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ABSTRACT

This course in technical communications is one of 16 courses in the Energy Technology Series developed for an Energy Conservation-and-Use Technology curriculum. Intended for use in two-year postsecondary technical institutions to prepare technicians for employment, the courses are also useful in industry for updating employees in company-sponsored training programs. Comprised of eight modules, the course shows the technician how to develop ideas in a clear, organized fashion. The exercises provided help the student practice writing and speaking skills that will not only aid him/her in the transfer of information, but also have an effect on his/her advancement. Written by a technical expert and approved by industry representatives, each module contains the follwing elements: introduction, prerequisites, objectives, subject matter, exercises, laboratory materials, laboratory procedures (experiment section for hands-on portion), data tables (included in most basic courses to help students learn to collect or organize data), references and glossary. Module titles are Introducing Technical Communications, Conducting and Reporting Research, Writing Outlines and Abstracts, Writing Definitions, Describing Mechanisms, Describing a Process, Performing Oral and Visual Presentations, and Putting Skills Into Practice: Formal Report and Presentation. (YLB)

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COMMUNICATIONS

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PREFACE

ABOUT ENERGY TECHNOLOGY MODULES

The modules were developed by CORD for use in two-year postsecondary technical institutions to prepare technicians for employment and are useful in industry for updating employees in company-sponsored training programs. The principles, techniques, and skills taught in the modules, based on tasks that energy technicians perform, were obtained from a nationwide advisory committee of employers of energy technicians. Each module was written by a technician expert and approved by representatives from industry.

A module contains the following elements:

Introduction, which identifies the topic and often includes a rationale for studying the material.

Prerequisites, which identify the material a student should be familiar with before studying the module.

Objectives, which clearly identify what the student is expected to know for satisfactory module completion. The objectives, stated in terms of action-oriented behaviors, include such action words as operate, measure, calculate, identify, and define, rather than words with many interpretations such as know, understand, learn, and appreciate.

Subject Matter, which presents the background theory and techniques supportive to the objectives of the module. Subject matter is written with the technical student in mind.

Exercises, which provide practical problems to which the student can apply this new knowledge.

References, which are included as suggestions for supplementary reading/viewing for the student.

Test, which measures the student's achievement of prestated objectives.

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INTRODUCTION TO TECHNICAL COMMUNICATIONS

Communication involves the transfer of an idea from one mind to another. The communicative process consists of a sender, a message, a medium, and a receiver.

First, the sender carefully selects the symbols (usually words) that form the message. Then, the sender must determine which method, or medium, of sending the message will work best. The receiver hears or reads the message and makes an interpretation. If the receiver's interpretation matches the sender's intended meaning, true communication has occurred. This seemingly simple process is more difficult to achieve than one might imagine.

In an ideal situation, the message is clear and the medium is adequate. Since the sender's portion of the communication process has been well-executed, the receiver should be able to clearly interpret the intended meaning. However, the receiver sometimes misinterprets the message because of the "noise" of selectivity.

Selectivity involves the human tendency to hear, or understand, only that information with which one concurs. Selectivity takes three forms: selective exposure, selective perception, and selective retention.

Selective exposure means that an individual will usually choose compatible ideas and attitudes with which to come in contact, thereby limiting the environment. Selective perception is the process of accepting information from the sender and "hearing what one wants to hear." Selective retention is the tendency to remember only what one wishes to remember.

Computers never have a problem with selectivity; people always do. Therefore, as long as one must communicate with other people, one must realize that selectivity does exist. The best ammunition with which to combat selectivity is clear, precise, interesting, well-organized writing and speaking.

Transference of exact meaning is especially important in technical communications. This is because the transfer of technical knowledge is important to company survival. Technology feeds on itself, each new development dovetailing into the next. Each link of the chain – whether that link be a formal technical report or an interoffice memo – must be sound. Not only must the communication be accurate, it must be clearly written so that there is no room for misinterpretation.

The ability to write and speak well is not important only for the transfer of information; writing capabilities, as well as speaking expertise, often have an effect on the employee's advancement. This course, Technical Communications, shows the technician how to develop ideas in a clear, organized fashion. The exercises included in each module will help the student put new skills into practice. Just as in the development of any new skill, practice is imperative to refinement and mastery.

Module TC-01, "Introducing Technical Communications," explains the purpose of the course, provides a definition of technical writing, lists the basic principles of technical writing, and discusses how audience adaptation, the scientific attitude, and mechanics contribute to technical writing style.

Module TC-02, "Conducting and Reporting Research," delineates preliminary research steps, explains how to take notes and how to assemble a list of sources, shows how to utilize the best research tools, clarifies the differences between reporting in writing and reporting orally, and between constructing formal and informal reports.

Module TC-03, "Writing Outlines and Abstracts," points out the importance of having a plan, demonstrates effective outlining steps, and illustrates topic and sentence outline forms. The module also discusses the types of abstracts, gives suggestions for writing abstracts, and explains the purpose for including an abstract.

Module TC-04, "Writing Definitions," interprets what words should be defined and explains how formal and informal definitions are constructed. The fourth module also diagrams where definitions should be placed within the text.

Module TC-05, "Describing Mechanisms," lists the components in the description of a mechanism and points out some potential problems.

Module TC-06, "Describing a Process," explains how to sketch a process, lists the types of processes, and discusses how to write instructions.

Module TC-07, "Performing Oral and Visual Presentations," explains the importance of considering the audience, lists suggestions for using visual aids, discusses how to prepare for and conduct an interview, gives tips for leading group discussions, and shows how to use and construct charts and graphs.

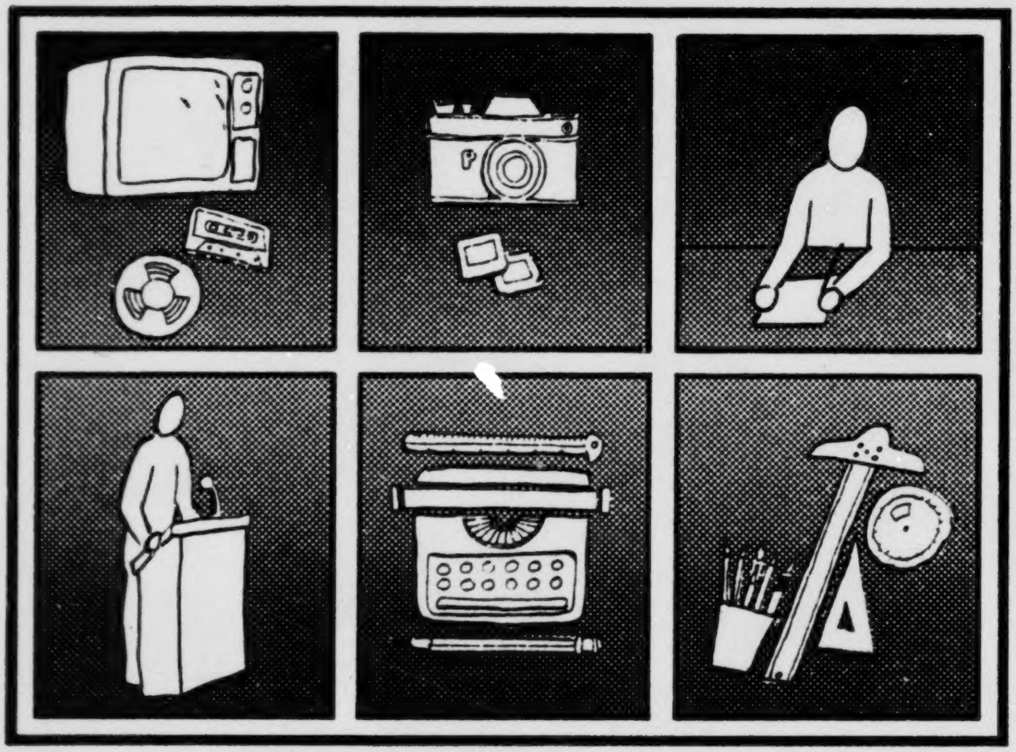
Module TC-08, "Putting Skills Into Practice: Formal Report and Presentation," allows the student to have an opportunity to apply new writing and speaking skills in a cohesive effort. The student will select a topic suitable for a formal report, conduct preliminary research, construct and adapt an outline, take notes, write a rough draft, and present an oral report that includes a defense and a question-and-answer session. The eighth module is a culmination of the writing and speaking skills that have been developed in modules one through seven. Therefore, this module can be used by both the instructor and the student to evaluate progress.

The author of Technical Communications assumes that the student is competent in spelling, grammar, and punctuation. If this is not the case, there are many helpful texts that can assist the student. The focus of this course is on teaching the student to communicate clearly and well in a technical environment. Topics addressed are those suitable for the industry-oriented student who wishes to cultivate writing and speaking skills as these abilities apply to the workplace.

ENERGY TECHNOLOGY

CONSERVATION AND USE

TECHNICAL COMMUNICATIONS



MODULE TC-01

INTRODUCING TECHNICAL COMMUNICATIONS

CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

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CORD

CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

INTRODUCTION

Every person who works in industry must be able to communicate with others, both orally and in writing. For some technicians, the task of writing memos and making out reports is seldom needed; for others, it is an everyday duty. Regardless of how often the skill is used, communicative ability is a requirement for getting a job, for keeping it, and for being promoted within the organization. Whether a report be a one-page, fill-in-the-blank maintenance report or a 200-page proposal, each is critical to a company. An oral presentation may affect a million dollar climate control system. The person preparing the written or oral report is being paid to be accurate and effective.

The purpose of this course is to prepare the technician to handle everyday writing and speaking duties. Since writing skills are usually more difficult to acquire and perfect, more time will be spent discussing writing than speaking.

This module is an introduction to the Technical Communications course. Its purpose is to acquaint students with five important aspects of technical communications: (1) a definition of technical writing, (2) the basic principles of technical writing, (3) technical writing styles, (4) mechanics, and (5) an introduction to oral communications.

PREREQUISITES

The student should have completed at least one semester or quarter of college-level English composition.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. Compare an example of technical writing and an example of nontechnical writing, showing similarities and differences.
2. Define technical writing by listing and defining its five characteristics.
3. Analyze examples of technical writing by describing how they contain the five characteristics.
4. List and define five principles of technical writing.
5. Analyze an example of technical writing to determine if it follows the five principles.
6. List and explain the main considerations in technical writing style.
7. Rewrite poorly written items, correcting errors in style and mechanics.
8. List and explain the most important aspects in technical writing style.
9. List the reasons for studying oral communications.

PURPOSE OF COURSE

Technical communications, which consists primarily of technical writing and oral presentations, may sound as though it is practiced only by professional writers. Actually, any technically trained person with some education beyond high school is engaged in some form of technical communications. Experts have estimated that for every piece of equipment manufactured, 20 pieces of writing are generated. If even half this number is correct, most technicians are involved in technical communications in some way. Their jobs depend on it.

Many times a person chooses a technical field without realizing that to succeed in it, one will be required to write reports, orders, instructions, letters, memos, and give oral presentations. Even the most work-oriented technician must communicate with others. Usually, the higher the salary involved, the more writing and speaking tasks required of the technician.

Most technical communication is prepared to help someone do something or make decisions. The technician has information and shares it. This can be exciting for the person who has the ability to "get things down on paper" or "put it into words." But for the person who knows the information – yet is not capable of conveying it – poor writing skills often mean staying in a low-paying job.

Why study technical communications? Two reasons are clear. Most technical jobs require it. Promotions and good salaries depend on it. Furthermore, communicating can be fun and exciting for the technician who must explain a project to the boss or pass along test results to the next technician. Even when ordering parts, refined communication skills will be helpful.

A discussion of technical communications could cover many areas, but this module is restricted to a definition, some basic principles, some characteristics of technical writing style and mechanics, and a brief introduction to oral communication. It is necessary that the technician thoroughly understand this information before those essential on-the-job reports can be constructed. Technical writing is logical. This quality often makes technical writing easier than other types of writing.

DEFINITION OF TECHNICAL WRITING

First, what is technical writing? Obviously, technical writing deals with science and technology in some way. Normally, technical writing is mere exposition (writing that explains) about technical and scientific subjects. This writing can be very simple or highly complex, but it must (1) deal with a scientific subject and (2) reflect certain characteristics.

A short example of technical communication could be the instructions on a medicine bottle: "Two capsules three or four times daily. No more than a total of eight capsules in any 12-hour period."

The following excerpt, taken from a course on Mechanical Devices and Systems, is an example of mechanical technical writing: "The shaft forms an integral part of almost all power transmission equipment. Its basic function is to transmit power from the power source to drive components such as pulleys, sprockets, gears, and couplings."

Technical communication can result in a number of end products, such as the following:

- Business letters
- Reports
- Journal articles
- Abstracts
- Oral presentations
- Instructions
- Memos
- Brochures
- Proposals
- Graphic aids

What characteristics typify technical writing? First, as mentioned previously, technical writing always deals with a scientific matter, whether that subject be how to start a lawnmower, the progress of a lab experiment, how clouds form, what procedures must be followed in bench testing an air conditioning compressor, or how to build a nuclear weapon.

The second characteristic, which represents perhaps the most outstanding difference between technical writing and some other types of writing, is that the technician always has in mind a specific reader or group of readers who have similar backgrounds. In other words, technical communication is always aimed toward a specific audience (person or group).

If the technician writes to a target audience, it follows that every aspect of that writing (or speaking) — vocabulary, graphics, everything — must be adapted to the level of the person or persons for whom the communication is intended. This does not necessarily mean that the language of the writing (or speech) should reflect a certain level, e.g., junior high or college level. It simply means that the material is aimed carefully and directly at a specific person or group.

Third, technical writing follows certain forms, which various authors refer to as its formal aspect. These forms – special vocabularies, graphic aids, and conventional report forms – are usually specified by the organization for which the writing is being done. For instance, even a daily log kept on a machine must be recorded in a certain form. In this context, formal should not be confused with formal vs. informal. "Formal" does not mean that the writing sounds formal; it simply means that the writing follows certain forms or formats. Although technical writing often sounds dignified, in this case, formal refers to form – not dignity.

"Form" often means style and format specifically required by the organization. It is important that the technician study the required format and follow it to the letter – which means adhering to the correct formal aspect. This could include using bold headings, prescribed punctuation, designated graphics, or other such items.

Often the communication can sound dignified because of its fourth characteristic: a scientific point of view. Most such writing – and speaking – is clear and concise, unemotional, and objective. It is not intended to amuse, entertain, or even educate in the broad sense. The singular intent is to inform in the clearest possible way.

Consider the following examples. A service manual is not intended to be recreational reading. A test report is not intended for the general public. A parts order is not designed to be interesting. An oral presentation is not an after-dinner speech. In each case, clarity is of the utmost importance. And clarity, as stated before, is achieved by writing for a specific person or group — a condition that cannot be avoided. Clear communication always means having a particular audience in mind.

The fifth characteristic of technical writing is the use of certain techniques — definitions, descriptions of mechanics, descriptions of operations or actions, classifications, and interpretations — which are the building blocks of most writing that a technician does. When the technician is familiar with each tool necessary for communication, almost any writing assignment is possible. For this reason, this course includes major discussions of each technique. For example, consider the following:

- Most reports contain a few definitions, both simple and complex.
- Although instructions must explain how something works (description of an operation), the writer must also describe the device and its parts (description of a mechanism).
- Groups of items must be classified or separated into "piles" determined by some principle or basis.
- Facts, too, must be sorted and evaluated. This is interpretation.

In summary, the preceding has presented important background details, including a definition of technical communication, some reasons for studying technical communication, a comparison of technical and nontechnical writing, and some characteristics of technical communications.

BASIC PRINCIPLES OF TECHNICAL WRITING

Are there some basic rules for good technical communication? The answer is "yes." In fact, there are many fundamental rules and principles for good technical style, but the following five, selected by Mills and Walter in Technical Writing, 4th ed., appear to be the most widely accepted:

1. Always have a specific audience in mind, even if this audience is an imaginary one. Assume that the audience is intelligent, but uninformed, on the subject.
2. Have a specific purpose in mind. Be sure that every sentence, word, and illustration contributes to that purpose.
3. Use simple, specific, concrete, and familiar language.
4. When beginning each section, tell the audience what each section will contain. At the end of each section, summarize. In other words, "Tell them what you are going to tell them; tell them, and then tell them what you told them."
5. Make all reports appropriately attractive and neat.

As previous paragraphs have stressed, having a definite audience in mind is essential. A technician is never allowed to write a report and then pick out a reader. In addition, each piece of communication has a definite purpose. Perhaps the purpose is to instruct, perhaps to inform, perhaps to enable the person to perform an operation. Regardless of the purpose selected, the technician must leave out anything that does not contribute to that purpose.

The writer must use clear language. If the term is targeted to a specific reader, then the writer will know what level of language to use. What might be a complex term for one reader might be the simplest word for another. An uninterested party can sometimes help find unclear passages by reading what the technical writer has written.

Telling the reader or listener what to expect is also helpful. This can be compared to giving a group a roadmap of an unfamiliar area and then giving them a tour. The tourists know what they are going to see before they see it. In writing, beginning statements like, "The purpose of this report is..." or "When you examine the project, please look for these three developments..." or "The test produced these results..." are ways of preparing the reader for what is to follow. Since most technical communication is designed to help another person, it is essential that the reader – or listener – understand the material. Introductory statements of purpose and initial or beginning summary statements can ensure that the reader does not miss anything. A summary does the same thing. The writer should not worry that he or she is repeating the same items several times. Remember, the purpose of technical writing is to help the reader understand.

The last principle – make all reports appropriately attractive – means that the technician must again evaluate the audience and the purpose. If the report is a simple log of the performance of a machine, neatness and accuracy will probably be enough. If, on the other hand, the report details the progress of an important energy research project and will be distributed to the top administration, more time should be spent on illustrations, binding, typing, and other aspects. The technician, regardless of level, never escapes having to analyze the audience and the purpose of each piece of communication.

STYLE

So far, this module has briefly discussed the definition of technical communication, its fundamental characteristics, and its basic principles. The next topic is style, i.e., how reports and other such end products are presented.

Style is applied to many areas of life: clothing, houses, automobiles, art, dancing – almost anything. Style can be defined as "a distinctive manner or mode of expressing, presenting, or doing something." In communication, style is the way an idea or explanation is presented. In other words, style involves the language that is used.

Style in technical writing can involve audience adaptation, scientific attitude, and mechanics.

AUDIENCE ADAPTATION

Once the purpose of an item is assigned or selected, most experts agree that audience adaptation heads the list of requirements for good technical communication style. And seeing the subject from the reader's viewpoint is part of audience adaptation.

For instance, is the intended reader an individual or a group? If it is a group, what kind? If it is an individual, is it one who is known by the writer or one known only by reputation? After these questions are answered, then everything – terminology, illustrations, calculations, length, the introduction – should be adjusted and adapted to fit the audience.

The purpose for writing to a target audience is clear. The likelihood that the writer will be present when the reader tackles the report is remote; therefore, the report should eliminate any need for explanations. Similarly, if the technician is speaking to a group of several hundred people, eliminating the chance for questions afterwards, the oral report should be clear to the audience. If it is not clear, the technician failed to adapt writing or speaking to the target audience.

Just as a poem and a manual for a lawnmower have different purposes, purposes for technical communications differ. For instance, a construction foreman asking for a progress report on a solar-powered heating unit being installed does not need a lengthy discussion on how to size tubing. However, the late shift in a cooling system test lab needs concise information, not generalities, from the first shift. Likewise, the owner of a company may need a detailed report on a mechanical breakdown or the reasons for purchasing new equipment to replace outdated equipment. Perhaps an oral presentation to several businesspersons on the reasons for converting to solar power, on the other hand, may need to be rather basic.

What elements in a technician's report must be adapted? Everything. Every part, in some way, is influenced by the intended audience. To be more specific, the writer must adapt three main elements – vocabulary, sentence structure, and organization.

First, how does one adapt vocabulary? The easiest way is to avoid using words the audience does not know. Very few bosses complain that reports from their workers are too simple. However, if the technician must use a word that the audience may not know, the word should be defined. This important point is discussed in detail in a later course module.

What about sentence length? Ordinarily, sentences should be relatively simple. "Relatively" means "it depends on the reader." For instance, complicated ideas should be in sentences that average no more than 10 to 12 words. On the other hand, simple ideas may be expressed in sentences that average twice as long. The writer should remember that the technician's task is to communicate as clearly as possible, not impress the reader. Therefore, if there is a real question in the writer's mind about the educational level of the audience, the writer should read other items written for the same person or group of persons, look carefully at the style of the other materials, and then aim the writing to the same level. This suggestion also applies to vocabulary, complexity of coverage, and other sentence structure characteristics.

The third element requiring written adaptation is organization. Normally, the writer organizes material in the normal way: introduction, body, and conclusion. In this order, the writer explains the purpose of an experiment, describes the experiment, and then states the conclusions. However, this "normal" organization can be adapted if the writer is not sure how much of the experiment the reader will understand or have time to read. A summary of the conclusion can be stated at or near the beginning. The reader who does not have the background to understand the experiment, or does not have the time to read the details, may simply read the introductory conclusions and skip the rest.

On the other hand, the reader who wishes to read all the report may do so. Using this procedure, it is possible that the manager, foreman, or owner of the company may read only the report's conclusions; whereas, the lab technician may read the entire report.

To summarize this section on audience adaptation, the following question is repeated: What must be adapted to the audience? Everything. More specifically, the technician should adapt vocabulary, sentence structure, and organization to the target audience. Nothing takes the place of a few minutes spent reading other items prepared for the same reader. It may save rewriting, confusion, or correcting another technician's mistakes.

The technician should also consider how the report will be used. Is it a proposal to persuade top management to make major changes, or is it general reference material? Will it be used as a guide for several future decisions, or will it be read once and thrown away? Will it be used under specific conditions or in a number of situations? Will it be used as a set of instructions or just general information? The writer's ability to know the answers to these questions, and to adjust his or her material to suit the audience, will make the writing more useful and definitely impress the person paying for the report.

SCIENTIFIC ATTITUDE

The second characteristic of technical communication is what is commonly called the "scientific attitude." This means that technical writing sounds dignified and objective. To be more specific, scientific attitude concerns (1) accuracy of facts, (2) care in acquiring and evaluating facts, and (3) formality and objectivity in reporting facts. Reports are not intended to be humorous; they are impersonal. They usually do not reflect opinions, and they must be accurate and clear.

The following three questions are ones often asked by writing students: (1) "Can I use personal pronouns?" (2) "Do I always have to use active voice?" (3) "Can I use masculine pronouns?"

First, can the technician use the personal pronouns "I," "we," "you," "us," or "our?" Modern style has softened a little, and many companies do allow "I" or "you" under certain circumstances; but personal pronouns can usually be avoided as follows:

1. I have tested the new machine.
2. We have tested the new machine.
3. The lab technician tested the new machine.
4. The new machine was tested.

In the sentences above, the first two sentences contain personal pronouns. These pronouns were replaced in the last two sentences.

The personal pronoun "you" is the most common and most familiar; therefore, "you" slips in the easiest. Consider the first sentence below:

1. If you forget to turn on the machine ... .
2. The operator should not forget to turn on the machine ... .
3. It is necessary to turn on the machine.

The last two sentences above show ways of omitting "you" in technical writing. The writer should avoid statements such as "The package contains your instructions" when a statement like "The package contains instructions" is more clear. Most authorities suggest avoiding first and second person pronouns (I, we, you) unless one knows they are acceptable in the organization.

The next question is, "Do I always have to use active voice?" Active voice means the subject of the sentence is doing the acting, as in "The operator started the machine." Passive voice means the subject is receiving the action, as in "The machine was started by the operator." In most cases, the active voice is more forceful, less wordy, and more interesting.

In the following example, the first sentence, which uses the active voice, is better:

1. The four experiments produced similar results.
2. Similar results were produced by the four experiments.

In some instances, however, the active voice may not be best. In the two sentences below, the second one – which is passive – is shorter and clearer:

1. They examined the first machine and found it was better.
2. An examination of the first machine showed it to be better.

Not only is the first sentence longer, it contains the pronoun "they," without telling to whom "they" refers. In summary, use active or passive voice, whichever is clearer and uses fewer words.

"Can I use masculine pronouns?" asks the technician. "Will my company let me say 'The machinist should bring his hammer,' or will I have to say, 'The machinist will have to bring his or her hammer?'" The rules for writing state that "he," rather than "he or she," is correct. Modern trends and pressures have required some companies to avoid references to one sex over another. Check the company style guide. Consider the audience. If the item is being distributed only within the organization, the question probably is not as important as it would be if the material were intended for a wider audience. The standard rule applies:

"When in doubt, leave it out" - or write around the problem. Simply say, "The machinist should bring a hammer."

MECHANICS

This section on style would not be complete without some comments on mechanics. This course assumes that the student has finished at least one writing course at the college level. Therefore, nothing is included concerning subject-verb agreement, comma splices, spelling, pronouns, pronoun-antecedent agreement, and similar grammar problems. Nevertheless, some suggestions on the mechanics of style may be helpful:

- Always choose the most precise word.
- Adjust length and complexity of sentences to the reader.
- Adjust paragraph construction and length to the reader.

Of these three suggestions, choosing the right word seems to be the most difficult suggestion to follow. Perhaps two misconceptions influence the technician: the feeling that (1) the writing of an educated person must sound a little more sophisticated and be a bit more complex than the average worker's and that (2) an expert in a subject should use a large number of technical words that a non-technician does not understand. Neither statement is true. As stated previously, good technical writing is writing the reader can understand; the material should inform above everything else.

What are some ways of choosing the right words? The following suggestions are criteria:

1. Choose the most accurate word. There are slight differences between "advise" and "inform," "few" and "less," "infer" and "imply," "theory" and "opinion."
2. Be specific. Attached could mean "welded," "soldered," or "bolted." "Device" could be a machine, a test instrument, or a tool. Choose the exact term.
3. Leave out unnecessary words. "This is the definite answer" could read, "This is the answer." "The house was built for the purpose of providing storage" could read "the house was built to provide storage." Modifying words, such as "appreciable," "comparative," "negligible," and "relative," are often ambiguous and can be avoided. The writer should make words like "suitable," "reasonable," and "sufficient" have a definite reference. For instance, "The project will be finished in a reasonable amount of time" is indefinite.
4. Use simple words with which the reader is familiar. Unless the writer or speaker knows the intended audience, this rule means little. The writer must use simple, clear language. Beginning writers often feel that substituting simple words for technical terms will result in a less precise meaning or will sound less professional. This is wrong. As stated previously, no one ever complained that a report was too simple. The writer should use "begin," not "instigate"; "pay," not "compensation"; "start," not "activate."
5. Avoid technical jargon when possible. Choosing simple words also means avoiding technical words if the reader or listener may not know what they mean. Such terms may be familiar to the reader. However, if they are not known to the reader, confusion can result. "Pot" (potentiometer), "meg" (mega-hertz), and "mic" (microm-

eter) may be familiar only to a person in a specific field. The writer must always choose words with the audience in mind.

Sentences and paragraphs should also be constructed with the reader in mind. An average sentence should be no longer than 20 words. If the reader is not familiar with the subject, shorter sentences are in order. Precise instructions often require short sentences.

Paragraph length is dictated by the subject being discussed. A paragraph normally starts with a topic sentence. The remainder of the papagraph develops the first idea.

One other consideration is eye relief. Long paragraphs, even if they are only about one subject, do not make easy reading. It is difficult for a reader to follow a page-long paragraph.

If the writer really wants the reader to know and understand the material, the material should be divided into shorter paragraphs. For instance, in a report of three lab test results, the reader could more easily understand three short paragraphs than one long one.

INTRODUCTION TO ORAL COMMUNICATIONS

Even though the major portion of this course is devoted to the written aspects of technical communications, this in no way lessens the importance of oral communication for the technician. Most people spend more job time speaking than writing. The technician is no exception. Instructions are usually given orally first and then in writing. The technician may also need to explain written items to other employees.

Only one module is directed toward oral communication because many of the suggestions for written communication apply: audience adaptation, scientific attitude, and organization, just to name a few. Although the technician will spend more time communicating orally than in writing, writing skills usually seem to require more study and practice.

The module on oral communication concentrates on the organization of oral presentations. As in written materials, oral reports should be clear and informative above all else. The listener must understand the speaker; this is often critical for the organization.

Clear and informative presentations also involve suitable graphics; therefore, visuals receive major emphasis in the module covering oral presentations. The listener who hears the presentation only once must be appealed to through as many senses as time and resources will permit.

EXERCISES

1. Choose an example of technical writing and an example of nontechnical writing and compare them, noting similarities and differences. The technical writing example can be a chapter from a book or a magazine article. The other item can be a short story, an essay, a chapter from a novel, or any other nontechnical example. Examine items such as intended reader (audience), organization, subject matter, scientific attitude, word choice, sentence and paragraph length, and other characteristics presented in this module. This analysis should be 300 to 500 words and should begin with a clear, concise introduction.
2. Write a 300 to 500-word paper examining a technical article or a chapter from a technical book to determine if it contains the five characteristics of technical writing. Use as many direct references to the source as possible. Do not generalize, and do not summarize the article except to support a statement.
3. In 300 to 500 words, compare two technical articles or chapters to determine how well they follow the five basic principles of technical writing. Use direct references to support all statements; do not generalize. Start with a clear introduction.
4. Rewrite the following sentences, making them clearer and more specific:
    a. Prior to evaluating the new equipment, condensed moisture should be adequately removed from the equipment by either tilting or inverting, whichever is more compatible with the configuration of the item.

b. Red numerals have been attached to identify the various adjustment knobs provided inside the door of the item.

c. It would seem to be a relatively desirable objective to terminate the previous process and to initiate the new one if reasonably optimum results are to be sufficiently obtained.

d. The first thing that must be adequately accomplished is to initiate the new plan.

5. Combine the following short sentences into one well-constructed longer sentence.

   a. We finished sanding the surface. We gave it a new coat of paint.

   b. These reports show that the new engine has failed to perform. The writer does not explain fully.

   c. Now we have the required cable. The lines can be laid to the project. Delay is no longer necessary.

REFERENCES

Andrews, Deborah and Blickle, Margaret. Technical Writing: Principles and Forms. New York: MacMillan Publishing Co., 1978.

Campbell, John S. Improve Your Technical Communication. Los Angeles: GSE Publications, 1976.

Lannon, John M. Technical Writing. Boston: Little, Brown and Company, 1979.

Mechanical Devices and Systems. Waco, TX: Technical Education Research Center - Southwest, October, 1979.

Mills, Gordon H. and Walter, John A. Technical Writing, 4th ed. New York: Holt, Rinehart and Winston, 1978.

Ross, Peter Burton. Basic Technical Writing. New York: Thomas Y. Crowell Company, 1974.

1. Define the following characteristics of technical writing:
   a. Scientific subject matter –

   b. Formal aspect –

   c. Scientific point of view –

2. List five special techniques that are the building blocks of technical writing.

3. List and define five principles of technical writing.

4. What is reader adaptation? What must be adapted? What are some suggestions for adapting material to a reader?

5. What are some characteristics of scientific attitude?

6. Should personal pronouns be used in technical writing? Explain.

7. List three ways of choosing the right word in technical writing.

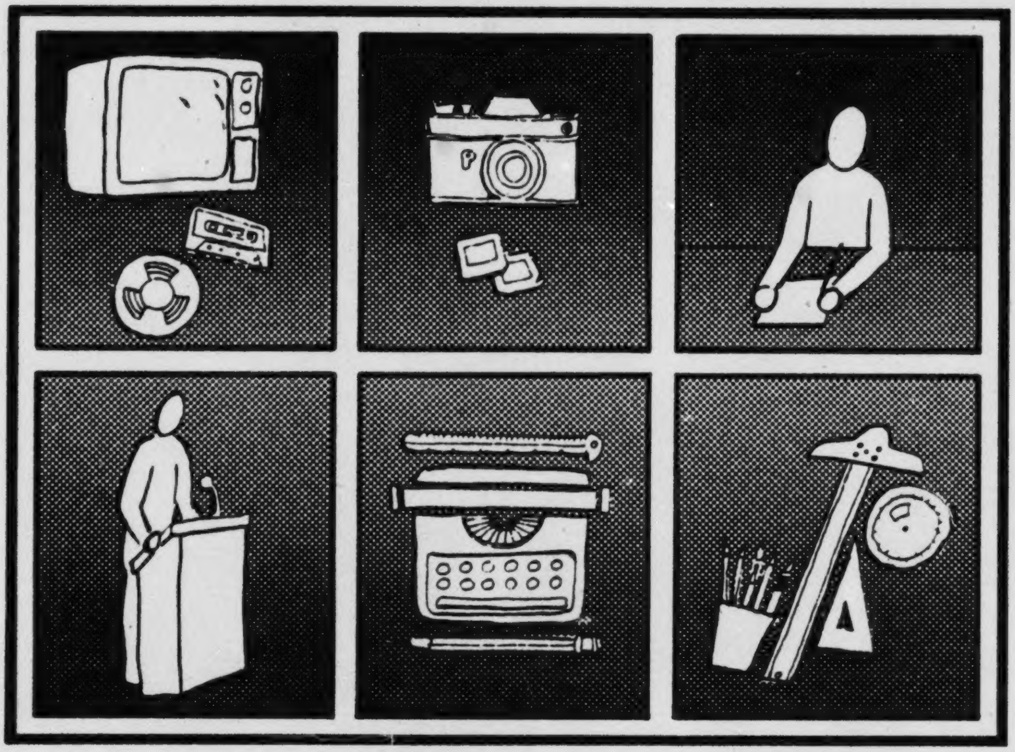
8. Why is a module on oral communication included in a course about technical communications?

9. What are some suggestions for written communication that also apply to oral communication?

ENERGY TECHNOLOGY

CONSERVATION AND USE

TECHNICAL COMMUNICATIONS



MODULE TC-02

CONDUCTING AND REPORTING RESEARCH

CORD CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

INTRODUCTION

The communication assignments that a technician handles require many talents. Sometimes the answers to questions or problems must be researched. In these cases, the technician must put on the hat of the researcher. For instance, a report, an oral presentation, or a reply, often demands exact information available only through reading original documents. Where should the technician start this task? What methods should be used? How can results be reported? This module attempts to answer these questions and others. After providing background information, this module will discuss how to complete preliminary research steps, how to assemble a bibliography, and how to use research results.

PREREQUISITES

The student should have completed the first module of Technical Communications.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. List preliminary steps in conducting research.
2. Define the terms "primary" and "secondary" sources.
3. List four suggestions for conducting an interview.
4. List four steps in assembling a bibliography.
5. Define the term "accessing tools." List key types.
6. Know how to look for subject headings.

7. Understand the basic format of indexes like the Reader's Guide to Periodical Literature.
8. Define the terms "index" and "abstracting service."
9. Define the term "information center."
10. List five ways of utilizing the research results.
11. List four items of information that should appear on a note card.
12. Know how to construct an annotated bibliography.
13. Know the main differences between informal and formal reports.
14. Know how to construct each element of a formal report.
15. Know how to use subject indexes.
16. Construct a thoroughly-researched bibliography.
17. Construct an informal report.

CONDUCTING AND REPORTING RESEARCH

Although it may seem a bit unusual to insert a module on conducting and reporting research so early in Technical Communications, a closer examination of the specialized technician's duties will show that one must constantly stay abreast of technological developments. Technology is always in a state of change. The technical communicator must be aware of these changes. An energy specialist is expected to be aware of all new government and public developments. An electronic technician needs to keep up with important changes and improvements. An automotive specialist has to know about changes in the industry and in government regulations. In addition to keeping up with technological developments oneself, a technician often must help others keep up. This is accomplished through oral and written presentations.

Effective presentations require research, and doing research means using research tools. Research tools may be found in a college library, a public library, an industry's collection, or one's own research area. The technician's employer, supervisor, or customers expect an informed report; a technician becomes an expert by staying abreast of technology.

Staying current is difficult because technology changes so rapidly and a large bulk of technical material is being produced annually. Even in a highly-specialized field like laser technology, published material (in the form of articles, books, proceedings of seminars, and test reports) is constantly being disseminated. For example, the following facts from Andrews and Blickle's Technical Writing book (page 14, see References) show the staggering increase in published technical information:

1. From 1960 to 1974, scientific and technical books published in the United States rose from 3,379 titles published by 1960 to 14,442 titles published through 1974.
2. From 1960 to 1974, the number of scholarly journals in the United States increased from 1,490 to 1,945. The worldwide increase was from 18,800 to 49,440.
3. From 1960 to 1974, the number of scholarly articles increased from 106,000 to 151,000.
4. Federally-sponsored scientific and technical reports rose from 14,750 in 1960 to 63,060 in 1975.

The technician who manages to keep up with this information boom must be an active reader and researcher. Information dissemination is paramount during this century. The efficient technician is certainly not expected to be acquainted with everything being published, but the person who does little or no reading is soon of little use to the company.

To do any kind of research, from the very simple to the highly complex, the person must ...

- Follow certain preliminary steps.
- Assemble a list of sources.
- Efficiently utilize the material discovered.

The purpose of this module is to help the technician understand and employ these three steps. It is assumed that the student understands the basics of research, although some time will be spent in reviewing how to use the Reader's Guide and the card catalog.

COMPLETING PRELIMINARY STEPS

Before a technician tackles any research project, some preliminary steps should be followed. The term "research," in this context, means any type of systematic search for information — regardless of whether the information sought is a minor item or a mass of data that will result in a lengthy report or presentation. The careful performance of the requirements of each step will ensure efficient completion of the research task.

First, the researcher must have a specific purpose in mind. What answers does the researcher need? What problems are involved in getting answers? The technician's purpose may be to gather all test reports on a specific piece of equipment. Or perhaps the technician's purpose is to determine if the cost of changing from one source of power to another is practical. A clear understanding of the reason to conduct a search is important; having a clear purpose can be a real time-saver in doing research.

Second, the researcher should make a preliminary outline of his subject, unless the necessary information is brief. A tentative outline can be prepared using several methods. (See the module on outlining.) Though tentative, an outline provides a plan by giving the researcher an idea of the items to be sought and the route to be taken.

The reader must remember that the preliminary outline is tentative; therefore, construction is based on what is called an educated guess.

To make an educated guess, the researcher's first ideas should be those ideas already in mind. The module on outlining discusses brainstorming. Here is a good place to use the technique.

Outline ideas can also be generated by reading the table of contents from books in the appropriate subject area, or through perusing titles of related journal or magazine articles. The educated guess is based on these three pre-research, researched subject elements.

Third, the technician should estimate what portion of the research will involve primary, and which part secondary, sources. Primary material consists of facts and inferences made by the researcher through personal observation and experimentation. Secondary facts and inferences are those discovered by others and conveyed to the technician through conversations, interviews, or published information. In other words, primary material is original research the technician will have to carry out. Secondary material is data already published and requires only that the technician search journals and other publications.

Must all of the necessary information come from primary or secondary sources? Or some combination? These questions do not have to be answered in the early stages of research, but the researcher must realize that the answers may affect research methods. Just because the technician knows that the needed information is in print does not mean that finding the information will be easy. Conversely, the technician's having to conduct some experiments and do some reading does not mean that the project is difficult. Each assignment is simply different. Preliminary study helps determine, and in some cases eliminates, upcoming difficulties.

Fourth, the researcher may have to conduct some preliminary interviews with others whose work relates to the problem. It is wasteful to do library research to find answers available simply for the asking. Often an expert can condense the information and may even give the researcher hints that printed material does not.

If interviews are used, the researcher should follow the following suggestions:

1. Select the interviewee carefully. Time should not be wasted interviewing a person who cannot contribute.
2. The researcher should study beforehand to make efficient use of interview time.
3. Prepare a list of questions before the interview so that nothing will be omitted.
4. The interview should be scheduled. A drop in interview often catches the other person unprepared or too busy to talk.

The fifth step is perhaps the most important. The researcher must set definite boundaries. What time period will be covered – 5 years or 10? What are the geographic limits of the search? How specific must the information be? Who is the audience for the report or presentation? Answers to these and similar questions are necessary to guide research. Indefinite limits result in wasted time and frustration. Specific boundaries set the researcher's objectives and make the job simpler.

The sixth and last step is to assemble a preliminary bibliography of the sources. This bibliography provides the researcher with the tools needed to answer the question, solve the problem, prepare the report, or construct the speech. Since the bibliography is the key to the research, much of this module will deal with assembling the bibliography.

ASSEMBLING A LIST OF SOURCES

Any type of research depends on finding and listing helpful sources. This list, or bibliography, can take several forms. It may be annotated; the researcher may have written a brief comment or summary of each source. The bibliography may be on cards, on paper, typed, or handwritten. Regardless, some type of bibliography must be constructed. To assemble the bibliography, the researcher must (1) determine which tools are available; (2) construct the bibliography using the selected tools; and (3) make sure that the material is available and accessible.

Accessing tools, as they are called, include card catalogs, guides, bibliographies, index guides to government publications, dictionaries, encyclopedias, handbooks, and yearbooks. Selecting the tools for locating sources is probably the most confusing step because of the many possibilities. This discussion will be slanted toward technical reference tools, but the lists in this module will not include all possibilities.

The researcher who finds the answer to his query in one accessing tool may not need to look any further. On the other hand, all tools might need to be used. Certainly, each problem is handled differently, but the researcher should be familiar with as many tools as possible. Since accessing tools are not the real sources of information – but simply the method for locating the actual article, book, definition, or speech – the researcher should become familiar with the scope, method, and coverage of each accessing tool. It is more important to know how to find a fact than to know the fact itself.

As stated earlier, the heart of any research is the bibliography or list of possible sources. Perhaps only three or four sources are needed, which means a short bibliography. Perhaps the researcher is expected to determine what information is available, which may mean constructing a lenghty bibliography. Regardless of the extent of the search for material, the first step, after narrowing the research's purpose and limits, is to construct a list of materials.

SEARCHING SUBJECT HEADING INDEXES

Before searching the card catalog and the periodical indexes, there are a few other sources that could save the researcher time. First, under what subject headings will the material be found? The researcher knows the subject assigned, but what other similar ones could prove productive?

Two excellent sources for subject headings are:

1. Library of Congress Subject Headings (Library of Congress, Washington, D.C.).
2. Sears List of Subject Headings (H. W. Wilson Company, New York).

Although these references both deal with books, the subject headings can relate to any method of research.

USING THE CARD CATALOG

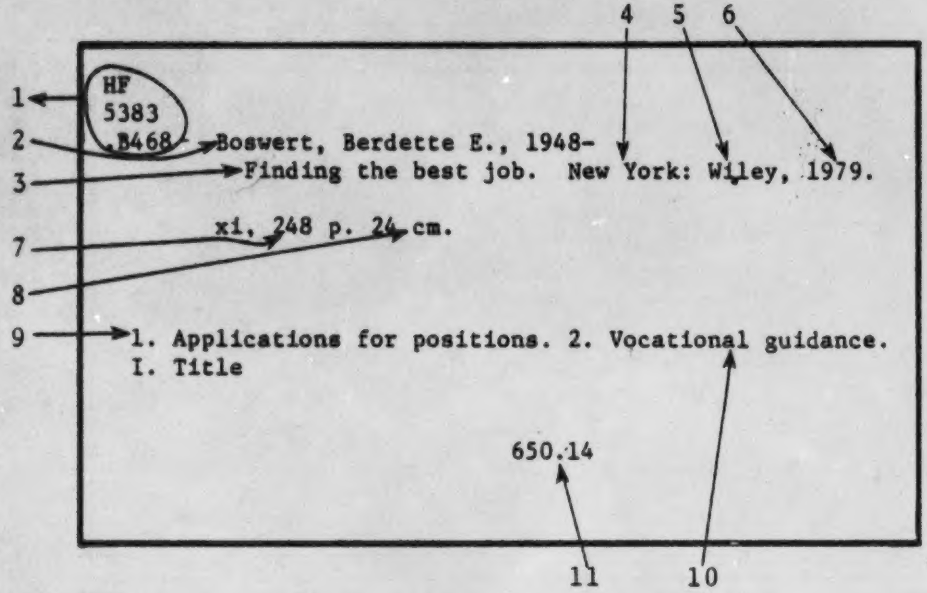
The card catalog, probably the most familiar research aid, is a library's systematic listing of books and materials. This does not mean that all of a library's materials will be indexed here. Periodical articles (material published with a fixed interval between issues), for instance, are located by using indexes. Indexes are discussed later in this module. The card catalog is a central listing of books and similar materials contained in a particular library. The card catalog is the first place a researcher looks when searching for items other than periodical articles.

It is a little difficult to decide whether to dicuss the card catalog at the first or the last of this section on compiling a bibliography. If the researcher needs some quick information, knows which book the answer is in, wants to see which books the library has, needs only a limited number of sources, or can only use this one library, then the card catalog is the first stop. In a more thorough search, the card catalog might be the last stop.

The card catalog indexes books by author, title, and subject. Author and title cards are usually filed in one section; subject cards are filed in another section. Some libraries have three sections. The card catalog contains many cross references so that if the researcher knows a related term, the correct term can probably be located. These cross reference helps should not be substituted for a trip to the sources of subject headings mentioned previously in this module.

Each card catalog contains a lot of information on the book it indexes. There is an author card, a title card, and a subject card — all on one book. Example A shows information that is included on each author card.

EXAMPLE A: AUTHOR CARD.


HF
5383
.B468 Boswert, Berdette E., 1948-
Finding the best job. New York: Wiley, 1979.

xi, 248 p. 24 cm.

1. Applications for positions. 2. Vocational guidance.
I. Title

650.14

KEY TO ABOVE NUMBERS:

1. Call number (Library of Congress system).
2. Author.
3. Title.
4. City of publication.
5. Publisher.
6. Date of publication.
7. Number of pages.
8. Size.
9. Subject heading.
10. Another subject treated.
11. Dewey Decimal class number.

The title card and subject card for the same book look like Examples B and C.

EXAMPLE B: TITLE CARD.

HF
5383
.B468

Finding the best job

Boswert, Berdette E.
Finding the best job/Berdette E. Boswert.
--New York: Wiley, 1979.

xi, 248 p.; 24 cm.

1. Applications for positions. 2. Vocational guidance.
I. Title

650.14

EXAMPLE C: SUBJECT CARD.

HF
5383
.B468

GUIDANCE--VOCATIONAL

Boswert, Berdette E.
Finding the best job/by Berdette E. Boswert.
New York: Wiley, 1979.

xi, 248 p.; 24 cm.

1. Applications for positions. 2. Vocational guidance.
I. Title

This module assumes the student is familiar with the two main library indexing systems — Library of Congress and Dewey Decimal. The first line of a call number, regardless of the system, is the classification number. Therefore, knowing that, under the Dewey Decimal system, books on applied arts and sciences all fall under 600-699 allows the researcher to browse if this is desirable. In the Library of Congrss system, all technical books are listed under T; but knowing that books on microprocessors are in the TK section and books on solar energy are indexed under TH is also helpful. Browsing is a poor way to find material, but a good way to become acquainted with the library — if that is the objective. However, browsing through book stacks or through a pile of periodicals to find specific information normally indicates a poorly-organized researcher.

CONSULTING SPECIALIZED GUIDES

Specialized guides to literature written about a particular subject should be consulted first. These overall guides index more specific guides, bibliographies, indexes, abstracts, and specialized dictionaries. The specialized guide groups the best sources, saving time. For example, the Engineering Libraries Division of the American Society for Engineering Education publishes guides for the following fields: Congress, Electrical and Electronics Engineering, Environmental Sciences, Industrial Engineering, Mechanical Engineering, Metallurgical Engineering, and Chemical Engineering. Here are some other helpful guides:

1. American Chemical Society. Searching the Chemical Literature. Washington, D.C.: American Chemical Society, 1961.

2. Blanchard, J. R. and H. Ostvold. Literature of Agricultural Research. Los Angeles: University of California Press, 1958.

3. Bottle, R. T. (ed.). The Use of Chemical Literature, 2nd ed. (Information Sources for Research and Development.) London: Butterworth & Company (Publishers), Ltd., 1969.

4. ______. and Wyatt, H. V. (eds). The Use of Biological Literature. 2nd ed. (Information Sources for Research and Development.) Hamden, Conn.: Archon Books, 1971.

5. Dick, Elie M. Current Information Sources in Mathematics: An Annotated Guide to Books and Periodicals; 1960-1972. Littleton, Colo.: Libraries Unlimited, Inc., 1973.

6. Herner, S. A Brief Guide to Sources of Scientific and Technical Information. Washington, D.C.: Information Resources Press, 1969.

7. Kobe, Kenneth A. Chemical Engineering Reports: How to Search the Literature and Prepare a Report. New York: Wiley-Interscience, 1957.

8. Malinowsky, H. Robert. Science and Engineering Literature: A Guide to Reference Resources. 2nd ed. Littleton, Colo.: Libraries Unlimited, 1976.

9. Sheehy, Eugene P. Guide to Reference Books. 9th ed. Chicago: American Library Association, 1976. Updated by periodic supplements.

10. Smith, Roger C. and W. Malcolm Reid. Guide to the Literature of the Life Sciences. 8th ed. Minneapolis: Burgess Publishing Co., 1972.

11. Walford, A.J. (ed.). Guide to Reference Material, Vol. 1: Science and Technology (1973), 3rd ed., Vol. 2: Social and Historical Sciences, Philosophy and Religion (1975). London: The Library Association.

12. White, Carl M. and associates. Sources of Information in the Social Sciences, 2nd ed. Chicago: American Library Association, 1973.

LOCATING BIBLIOGRAPHIES

A researcher can often locate a bibliography of the subject under study. Sometimes they are published separately, and a bibliography may index materials for some years back. In a few instances, the bibliography may be a complete volume. Often, a bibliography is simply the list of some sources following a journal or magazine article.

The researcher should be on the lookout for listings of sources within or at the end of articles. Firms often offer to send such lists; such offers should not be passed up.

As stated earlier, there are many bibliographies published as separate volumes. From the many published, the following can be useful in the fields of science and technology. Similar guides are published in other areas.

Dick, Elie M. Current Information Sources in Mathematics: An Annotated Guide to Books and Periodicals, 1960-1972. Littleton, Colo.: Libraries Unlimited, 1973.

Jenkins, Frances Briggs. Science Reference Sources. 5th ed. Cambridge, Mass.: The M.I.T. Press, 1969.

McGraw-Hill Basic Bibliography of Science and Technology. New York: McGraw-Hill Book Company, 1966.

Malinowsky, H. Robert, and others. Science and Engineering Literature: A Guide to Reference Sources. 2nd ed. Littleton, Colo.: Libraries Unlimited, 1976.

New Technical Books. New York: New York Public Library, 1915- . (Monthly except August and September.)

Science Books: A Quarterly Review. Vol. I-. April, 1965- . Washington, D.C.: American Association for the Advancement of Science, 1965- .

Scientific and Technical Books and Serials in Print, 1977. 4th ed. New York: R. R. Bowker Company, 1977. (Annual.)

Walford, A. J. (ed.). Guide to Reference Materials. Vol. I. Science and Technology. 3rd ed. London: The Library Association, 1973.

Ward, Dedrick C., and Wheeler, Majorie W. Geologic Reference Sources. Metuchen, N.J.: Scarecrow Press, Inc. 1972.

USING INDEXES AND ABSTRACT SERVICES

Indexes and abstracting services are helpful accessing tools. These accessing tools are keys to periodical literature, and periodical literature is the most current source for technical information.

Some suggestions for using indexes and abstracting services may prove helpful. First, the researcher should use as many terms as possible. Many indexes publish a thesaurus or list helpful terms under subject headings.

Second, begin with the most recent issue or material and work backwards. Recent listings and articles often give clues to earlier works.

Articles are usually classified by subject and by author in indexes; most indexes do not list a source by its title. A vertical (or publication) index surveys a single publication. Many electronics magazines include a yearly index that indexes the entire year's articles. Some magazines (National Geographic, Popular Mechanics, Modern Photography) have yearly indexes available upon request. Horizontal (or subject) indexes survey the literature in a certain field (chemistry, agriculture, solar energy). Probably the most utilized indexes are the H. W. Wilson publications; especially the Readers' Guide to Periodical Literature and Applied Science and Technology Index.

Most indexes follow the format of the Wilson publications, which makes using them easy. This module assumes the student is familiar with the Wilson format, which is like Example D.

EXAMPLE D: WILSON FORMAT FOR INDEXES.

1. $\overbrace{\text{Missile base labor rules face overhaul.}}^{1}$ $\overbrace{\text{G.C. Wilson.}}^{2}$
$\overbrace{\text{Aviation W}}^{3}$ $\overbrace{\text{74}}^{4}$:$\overbrace{\text{77+}}^{5}$ $\overbrace{\text{My 22 '61.}}^{7}$

2. $\overbrace{\text{Featherbedding on the pads.}}^{1}$ $\overbrace{\text{il}}^{6}$ $\overbrace{\text{Time}}^{3}$ $\overbrace{\text{77}}^{4}$:$\overbrace{\text{78-9}}^{5}$ $\overbrace{\text{My 5 '61.}}^{7}$

1. Title of article
2. Author
3. Abbreviation for magazine
4. Volume
5. Page or pages of article
6. Has illustrations
7. Date

A few minutes spent becoming familiar with the format of each index and abstracting service can save hours later.

An abstracting service lists and provides summaries or digests of periodical articles and other types of information. Abstracts may be translated into English, or they may be in the language of the original.

The most important rule to follow is: Thumb through the magazine last unless time is of no importance. The index cites sources that pertain to the subject; the abstracting service provides a brief summary of the article. The summary will help the researcher determine if the source is worth locating. Many abstract services tell how and where to obtain the complete item. The following indexes and abstracting services present a representative picture of those available.

1. Access. Evanston, Ill.: John Gordon Burke Publisher, Inc., 1979- . Indexes magazines not covered in other lists, new magazines, regional and city magazines.

2. Applied Science and Technology Index. New York: The H. W. Wilson Company, 1958- . (Monthly except August). Indexes periodicals by subject in aeronautics, automation, physics, chemistry, engineering, industrial and mechanical arts, electricity and electronics, and related fields.

3. Bibliographic Index: A Cumulative Bibliography of Bibliographies. New York: H. W. Wilson, 1937- . Lists bibliographies from many sources.

4. Bibliography of Agriculture. Washington, D.C.: National Library of Agriculture, 1942- . (Monthly with annual cumulations). Lists publications of U. S. government agencies. Excellent coverage of international literature of agriculture and related sciences.

5. Biological Abstracts. Philadelphia: Bioscience Information Service of Biological Abstracts, 1926- . (Biweekly with semiannual cumulations). Most comprehensive index and abstract to international bioscience research.

6. Biological and Agricultural Index. New York: H. W. Wilson 1964- . (11 issues with annual cumulations). Supersedes Agriculture Index, which was published from 1916 to 1964.

7. Business Periodicals Index. New York: H. W. Wilson, 1958- . (11 issues, cumulated annually). Indexes English language periodicals in all areas of business. Companion to Applied Science and Technology Index.

8. Chemical Abstracts: Key to the World's Chemical Literature. Columbus, Ohio: American Chemical Society, 1907- . Comprehensive average of 15,000 journals and of patents and books.

9. Computer and Control Abstracts: Science Abstracts, Series C. London: Institute of Electrical Engineering; New York: Institute of Electrical and Electronic Engineers, 1898- . (Monthly with semiannual cumulative indexes). International coverage of journals, books, and conferences dealing with computer and control engineering.

10. ERIC Documents (see Resources in Education).

11. Education Index. New York: H. W. Wilson, 1929- . Indexes periodicals, proceedings, and yearbooks dealing with most phases of the education world.

12. Electrical and Electronic Abstracts: Science Abstracts, Series B. London: Institute of Electrical Engineering; New York: Institute of Electrical and Electronic Engineers, 1898- . (Monthly with semiannual cumulative indexes). International indexes and abstracts to journals, bibliographies, books, reports, conference proceedings, and patents.

13. Engineering Index. New York: Engineering Index, Inc., 1884- . (Monthly with annual cumulations). General index to engineering literature, including reports and proceedings.

14. General Science Index. New York: H. W. Wilson Company, 1978- . (Monthly, except June and December; annual cumulation). Subject index of 88 English language periodicals covering pure and applied science.

15. Index Medicus. Washington, D.C.: National Library of Medicine, 1960- . International comprehensive subject and author index to medical literature.

16. International Aerospace Abstracts (IAA). New York: American Institute of Aeronautics and Astronautics, Inc., 1961- . (Semimonthly with annual cumulations). Abstracts of books, periodicals, conference papers, and translations related to aerospace science and technology.

17. Metals Abstracts. London: Institute of Metals; Metals Park, Ohio: American Society for Metals, 1968- . (Monthly; cumulated anually). International index of metallurgical engineering literature. Companion to Metals Abstracts Index.

18. New York Times Index. New York: New York Times, 1913- . Indexes and abstracts The New York Times by subject, person, and organization. Retroactive to 1851.

19. Newsbank. Greenwich, Conn.: Newsbank, Inc., 1977- . Indexes newspapers from major cities on selected topics. Updated periodically during the year. Articles available on microfiche.

20. Newspaper Index. Wooster, Ohio: Bell and Howell, 1972- . Indexes Chicago Tribune, Los Angeles Times, New Orleans Times-Picayune, and Washington Post by subject and personal name.

21. Nuclear Science Abstracts. Washington, D.C.: U. S. Energy Research and Development Administration (ERDA), 1948-1975. Abstracts and indexes published and unpublished information related to nuclear science and technology.

22. Physics Abstracts, Science Abstracts, Series A. London: Institution of Electrical Engineering; New York: Institute of Electrical and Electronic Engineers, 1893- . (Monthly with semiannual indexes). Indexes and abstracts international physics literature.

23. Readers' Guide to Periodical Literature. New York: H. W. Wilson, 1905- . (Eight issues a year with periodic and annual cumulations). Indexes U.S. general interest periodicals by author and subject.

24. Resources in Education, Educational Resources Information Center (ERIC). Washington, D.C.: U. S. Government Printing Office, 1975- . A monthly abstracting journal indexing educational literature by author, subject, and institution. Available in paper copy and on microfiche. Both sets commonly referred to as "ERIC Documents."

25. Science Citation Index. Philadelphia: Institute for Scientific Information (ISI), 1961- . (Quarterly with annual cumulations). Unique index which traces all of the resultant articles in which a known article is cited.

26. Scientific and Technical Aerospace Reports (STAR). Washington, D.C.: U. S. Government Printing Office, 1963- . International index of unpublished reports on space and aeronautics.

27. Social Science Citation Index. Philadelphia: ISI 1974- . Companion to Science Citation Index.

28. Social Sciences Index. New York: H. W. Wilson, 1974- .

29. Technical Book Review Index, 1935- . Compiled and edited in the Technology Department, Carnegie Library of Pittsburg. Pittsburg: The JAAD Publishing Company, 1977- . (Monthly). Indexes reviews of new books in all fields of science.

UTILIZING ENCYCLOPEDIAS

There are many encyclopedias devoted strictly to science and technology. The following list is a representative sampling and includes some the most helpful ones.

1. Above and Beyond: the Encyclopedia of Aviation and Space Science. Chicago: New Horizons Publications, Inc., 1967-1969. 14 vols.

2. Besancon, Robert M. (ed.). The Encyclopedia of Physics. 2nd ed. New York: Van Nostrand Reinhold Company, 1974.

3. The Cambridge Encyclopaedia of Astronomy. By the Institute of Astronomy at the University of Cambridge. New York: Crown Publishing Company, 1977.

4. Clark, George L. (ed.). The Encyclopedia of Chemistry. 2nd ed. New York: Reinhold Publishing Corporation, 1966.

5. Fairbridge, Rhodes, W. Encyclopedia of Atmospheric Sciences and Astrogeology (Encyclopedia of Earth Sciences, vol. II). New York: Reinhold Book Corporation, 1967.

6. ______. The Encyclopedia of Geomorphology (Encyclopedia of Earth Sciences, vol. III). New York: Reinhold Book Corporation, 1968.

7. ______. The Encyclopedia of Oceanography (Encyclopedia of Earth Sciences, vol. I). New York: Reinhold Publishing Corporation, 1966.

8. ______. The Encyclopedia of World Regional Geology. Part I: Western Hemisphere. New York: John Wiley & Sons, Inc., 1975.

9. Gray, Peter (ed.). The Encyclopedia of the Biological Sciences. 2nd ed. New York: Van Nostrand Reinhold Company, 1970.

10. *Grzimek's Encyclopedia of Ecology*. Edited by Bernhard Grzimek. New York: Van Nostrand Reinhold Company, 1977.

11. Hampel, Clifford, and Hawley, Gessner G. (eds.). *The Encyclopedia of Chemistry*. 3rd ed. New York: Van Nostrand Reinhold Company, 1973.

12. Hunter, David E., and Whitten, Phillip (eds.). *Encyclopedia of Anthropology*. New York: Harper & Row, Publishers, Incorporated, 1976.

13. *International Encyclopedia of Chemical Science*. Princeton, N.J.: D. Van Nostrand Company, 1964.

14. *Kingzett's Chemical Encyclopaedia*. 9th ed. Princeton, N.J.: D. Van Nostrand Company, 1966.

15. Lapedes, Daniel N. (ed.). *The Encyclopedia of Environmental Science*. New York: McGraw-Hill Book Company, 1974.

16. ________. *McGraw-Hill Encyclopedia of Energy*. New York: McGraw-Hill Book Company, 1976.

17. *The McGraw-Hill Encyclopedia of Science and Technology*. 4th ed. New York: McGraw-Hill Book Company, 1977. 15 vols.

18. *The McGraw-Hill Encyclopedia of Space*. New York: McGraw-Hill Book Company, 1968.

19. Newman, James R. (ed.). *The Harper Encyclopedia of Science*. Rev. ed. New York: Harper & Row, Publishers, 1967. 4 vols.

20. Ralston, Anthony, and Meek, C.L. (eds.). *Encyclopedia of Computer Science*. New York: Petrocelli Books, Mason/Charter Publishers, Inc., 1976.

21. Ridpath, Ian (ed.). *Illustrated Encyclopedia of Astronomy and Space*. New York: Thomas Y. Crowell Company, 1976.

22. Todd, David Keith (ed.). *The Water Encyclopedia: A Compendium of Useful Information on Water Resources*. Port Washington, N.Y.: Water Information Center, 1970.

23. *Van Nostrand's Scientific Encyclopedia*. 5th ed. Edited by D. M. Considine. New York: Van Nostrand Reinhold Company, 1976.

24. Williams, Roger J., and Lansford, Edwin M., Jr. (eds.). *The Encyclopedia of Biochemistry*. New York: Reinhold Publishing Corporation, 1967.

USING DICTIONARIES

Specialized dictionaries are available in many subject areas. Some the most useful ones are included in the following list.

1. *Black's Medical Dictionary*. 31st ed. Edited by William A. R. Thompson. New York: Barnes & Noble, Inc., 1977.

2. Challinor, John. *A Dictionary of Geology*. 5th ed. New York: Oxford University Press, 1978.

3. Collocott, T. C. (ed.). *Dictionary of Science and Technology*. London: W. & R. Chambers, Ltd., 1971. Successor to *Chamber's Technical Dictionary*.

4. *The Condensed Chemical Dictionary*. 9th ed. New York: Van Nostrand Reinhold Company, 1977.

5. De Vries, Louis. *French-English Science and Technology Dictionary*. 4th ed. Rev. and enl. by Stanley Hochman. New York: McGraw-Hill Book Company, 1978.

6. ______. and Devries, Herrmann (eds.). *German-English Technical and Engineering Dictionary*. 2nd ed. revised and enlarged. New York: McGraw-Hill Book Company, 1966.

7. Graf, Rudolf F. *Modern Dictionary of Electronics*, 5th ed. New York: Howard W. Sams & Co., 1977.

8. Grant, Julius (ed.). *Hackh's Chemical Dictionary (American and British Usage)*. 4th ed. New York: McGraw-Hill Book Company, 1969.

9. Gray, H. J., and Isaacs, Alan (eds.). *A New Dictionary of Physics*. Rev. ed. London: Longmans, Green & Co., Ltd., 1975.

10. Gray, Peter. The Dictionary of the Biological Sciences. New York: Reinhold Publishing Corporation, 1967.

11. Hampel, Clifford A., and Gessner, G. Hawley. Glossary of Chemical Terms. New York: Van Nostrand Reinhold, 1976.

12. James, Glenn, and James, Robert C. (eds.). James & James Mathematics Dictionary. 4th ed. New York, N.Y.: Van Nostrand Reinhold Company, 1976.

13. Jordain, Philip B. Condensed Computer Encyclopedia. New York: McGraw-Hill Book Company, 1969.

14. Lapedes, Daniel N. (ed.). McGraw-Hill Dictionary of the Life Sciences. New York: McGraw-Hill Book Company, 1976.

15. ______. McGraw-Hill Dictionary of Scientific and Technical Terms. New York: McGraw-Hill Book Company, 1974.

16. Lingeman, Richard R. Drugs from A to Z: A Dictionary. 2nd ed. New York: McGraw-Hill Book Company, 1974.

17. Marks, Robert W. (ed.). The New Dictionary & Handbook of Aerospace, with Special Sections on the Moon and Lunar Flights. New York: Frederick A. Praeger, Publishers, 1969.

18. Markus, John. Electronics and Nucleonics Dictionary. 4th ed. New York: McGraw-Hill Book Company, 1978.

19. Rogers, Harold A. (ed.). Funk and Wagnalls Dictionary of Data Processing Terms. New York: Funk & Wagnalls Company, 1970.

20. Sarnoff, Paul (comp.). The New York Times Encyclopedic Dictionary of the Environment. New York: Quadrangle Books, 1971.

21. Stenesh, J. Dictionary of Biochemistry. Philadelphia: Interscience Publishers, a division of John Wiley & Sons, Inc., 1975.

22. Thewlis, J. Concise Dictionary of Physics and Related Sciences. New York: Pergamon Press, 1973.

23. ______. The Encyclopaedic Dictionary of Physics. New York: Pergamon Press, 1961-1963. 9 vols. Supplements I and II, 1966, 1967.

UTILIZING HANDBOOKS

Handbooks are manuals or reference books that compile specific information, often in tabular form, on a specific or limited subject. Some examples are as follows:

1. Altman, Philip, and Dittmer, Dorothy S., ed. and comp. Biology Data Book, 2nd ed. Bethesda, Md.: Federation of American Studies for Experimental Biology, 1972. 3 volumes.

2. Altman, Phillip, and Dittmer, Dorothy S., ed. and comp. Environmental Biology. Bethesda, Md.: Federation of American Societies for Experimental Biology, 1966.

3. American Institute of Physics Handbook, 3rd ed. New York: McGraw-Hill Book Company, 1972.

4. Baumeister, T., ed. Standard Handbook for Mechanical Engineers, 7th ed. New York: McGraw-Hill Book Company, 1967.

5. Besacon, Robert M., ed. The Encyclopedia of Physics, 2nd ed. New York: Van Nostrand, 1974.

6. Burington, Richard Stevens. Handbook of Mathematical Tables and Formulas, 5th ed. New York: McGraw-Hill Book Company, 1973.

7. CRC Handbook of Chemistry and Physics: A Ready Reference Book of Chemical and Physical Data. Cleveland, Ohio: CRC Press, 1914- . (Annual)

8. Condon, Edward Uhler, and Odishaw, Hugh. Handbook of Physics. New York: McGraw-Hill Book Company, 1968.

9. Considine, Douglas M. (ed.). Energy Technology Handbook. New York: McGraw-Hill Book Company, 1977.

10. Gray, Asa. Gray's Manual of Botany. 8th ed. New York: American Book Company, 1950.

11. Handbook of Chemistry and Physics. Cleveland, Ohio: Chemical Rubber Company, 1914- . (Annual)

12. Howard, Neale E. The Telescope Handbook and Star Atlas. Rev. 2nd ed. New York: Thomas Y. Crowell Company, 1975.

13. Korn, Granino A., and Korn, Theresa M. Manual of Mathematics. New York: McGraw-Hill Book Company, 1967.

14. Lange, Norbert Adolph. Lange's Handbook of Chemistry. Edited by John A. Dean. 11th ed. New York: McGraw-Hill Book Company, 1973.

15. Metals Handbook. Metals Park, Ohio: American Society for Metals, 1961-1975. 10 volumes.

16. Perry, Robert H. (ed.). Engineering Manual. 3rd ed. New York: McGraw-Hill Book Company, 1976.

17. Sippl, Charles J. Computer Dictionary and Handbook. 2nd rev. ed. Indianapolis: Howard W. Sams Company, 1972.

USING YEARBOOKS

Most professional societies in each field issue a yearbook, condensing main occurrences for the year. In addition, most encyclopedias issue a yearbook that covers the year's news events and discoveries. Because there are so many yearbooks, no list will be attempted. The following are three typical yearbooks:

1. McGraw-Hill Yearbook of Science and Technology. New York: McGraw-Hill Book Company, 1961- . (Annual)
2. U. S. Department of Agriculture. Yearbook of Agriculture. Washington, D.C.: Government Printing Office, 1894- .
3. U. S. Department of Interior, Bureau of Mines. Minerals Yearbook. Washington, D.C.: Government Printing Office, 1933- .

EMPLOYING INFORMATION CENTERS

The information center is another accessing tool. Sponsored by universities, professional societies, and governmental or commercial organizations, information centers around the country answer questions, provide bibliographies, or furnish citations on computer printouts. Actual documents are not furnished. Each center is usually highly-specialized.

To obtain assistance at a center, the researcher confers with a specialist who draws up a search plan that the center's computer can understand. For instance, the Science and Technology Division of the Library of Congress includes a National Referral Center that answers questions and produces a series of guides to other governmental agencies. The Reference Section will produce bibliographies on specialized topics upon request. The National Technical Information Service is the chief clearinghouse for government reports.

A Directory of Information Resources in the United States: Physical Sciences and Engineering (Washington, D.C.: U. S. Government Printing Office, 1971) identifies the information centers. Such publications give the necessary addresses, phone numbers, holdings and services. Most centers charge for services, but cost is nominal.

Use of the information center is an excellent way to save time in completing a thorough search for sources.

UTILIZING THE BEST TOOL

After discovering what each tool can offer, the researcher often finds that the information in several tools overlaps.

The temptation is to narrow the research to one or two tools — like the card catalog and the Science and Technology Index. Only in a few instances is this the best approach; most problems require an investigation of all sources, since important information may appear in unexpected places.

In the process of using selected tools, the researcher should always make a separate index card for each potential item. Since these cards are for the researcher's benefit, the researcher may include notes in addition, but the necessary information is: call number or other key for locating material, author, title, and other bibliographical details.

The third step is to locate the actual documents. If the search is thorough, the researcher will have listed some sources that are not easily obtainable. An attempt should be made to locate all listed sources to determine which should be procured by other means.

USING RESEARCH RESULTS

Assume the researcher has performed the assigned tasks. Preliminary steps have been followed, a thorough bibliography has been assembled, and the documents have been located. Now the task is to use the material.

As stated in the first module, the technician seldom collects information and then sees who needs it. Probably, the information's format has been set. Research can result in (1) notes for future reference, (2) an annotated bibliography, (3) an oral presentation, (4) a short informal report, (5) a long formal report, or other forms.

The remainder of this module will suggest some methods for preparing each of these five items. The researcher must remember that format is dictated by the one requesting information. The researcher's objective is to follow the instructions to the letter, not to memorize them; instructions may change from assignment to assignment or from company to company. The company's stylebook is the rule.

TAKING NOTES

Note-taking is fairly standard, so not much will be said here. Notes should be on notecards, unless there is a specific reason to do otherwise. The following four pieces of information should be on every card:

1. The subject of the note, or the division of the outline if a preliminary outline has been made.
2. An identification of the source, which may be only the author's last name.
3. The page number or numbers from which this note was taken.
4. Notes that are applicable to the subject.

Notes are condensed unless the material may be needed in a direct quote later, or the material is in such exact language that summarizing it will distort meaning. If material is copied word for word, enclose it in quotation marks in the notes. Only material covering one subject should be placed on each card.

ASSEMBLING AN ANNOTATED BIBLIOGRAPHY

Assembling an annotated bibliography is time-consuming, but the annotated bibliography can certainly be one of the most useful results of research. The list of indexes and abstracting services earlier in this module is an example of an annotated bibliography. The researcher must locate and become familiar enough with documents to understand their purpose and organization. The researcher then writes a short description of each source. An analysis of the reader and the purpose for which the bibliography is being prepared determines what information to include in each summary. Annotations normally do not evaluate, but summarize sources. The researcher should know how to use annotated bibliographies, as well as how to prepare them.

REPORTING ORALLY

Quite often the result of the research is an oral presentation, given either by the researcher or by the person who asked that research be conducted. An oral report may be presented to one person or several hundred. A later module will give specific suggestions about presenting oral reports.

DISTINGUISHING BETWEEN FORMAL AND INFORMAL REPORTS

Both research results and the day-to-day operation of industry depend on reports. Reports are generally classified as either informal or formal. Sometimes it is difficult to tell the difference between the two types. The most obvious difference between formal and informal reports is the format. Formal reports have title pages, tables of contents, abstracts, and appendixes; informal reports usually have none of these. Some key differences in the contents are as follows:

	Informal Reports	Formal Reports
Scope	Attack either a problem of limited scope or one aspect of a large problem.	Attack all aspects of a broad problem.
Purpose	To convey departmental information or action; occasionally to relay portions of a report to management.	To convey major information to management or the public.
Readers	May be aimed at only one person or a limited group of persons who are usually technically informed.	May be read by many people at various technically-informed levels.
Emphasis	Emphasize the results of the investigation and the procedure used.	Provide necessary background in addition to results and procedure.

Informal reports are usually brief, and assume that the reader is familiar with the problem and the technical area. Formal reports are aimed toward a wider range of readers; therefore, less is assumed about the audience. More background and more details are included.

Informal reports are usually in one of three formats: the memorandum, the letter report, and the prepared form report. An informal report might be:

- A list of sources for further study
- A lab report
- A request for extra help on a project
- A proposal for a new project
- A brief set of instructions
- A cost estimate on a new project
- A progress report
- A malfunction report
- A recommendation for new equipment
- The results of an inspection
- An annotated bibliography
- The answer to a research problem

Regardless of whether the informal report is in memorandum, letter, or prepared form, the information portion usually follows this pattern:

- Introduction
    - Purpose of report
    - Problem to be tackled
    - Scope of the study
- Body
    - Presentation of information
- Conclusion, summary, and/or recommendations

The first paragraph should always introduce the report, even if the total report is brief. Objectives should be accomplished in the fewest words possible.

A memorandum, or memo, is the most common form of in-house communication and can cover almost any subject. A request for a part, the answer to a research problem, the source of a research question, a suggestion for a meeting, preliminary results of an energy survey — many subjects are possible. Companies usually furnish memo forms; the standard format looks something like Example E.

EXAMPLE E: TYPICAL MEMORANDUM.

Company Name

Date:

Reference Number:

To:

From:

Subject:

The technician should remember to include an introduction and conclusion and/or summary in the report, as in Example F.

EXAMPLE F: MEMO WITH INTRODUCTION AND CONCLUSION.

The Maymer Company, Inc.

Date: June 5, 1980

Reference Number: BJ-44-80

To: Jim Myers, Energy Auditor

From: John Frank, Testing Laboratory

Subject: Sources for facts on latest auditing regulations.

Here are the sources for information on the new regulations for conducting energy audits as you requested April 30. Items 2 and 4 are in the company library. The others are on order, but can be viewed in the local university library.

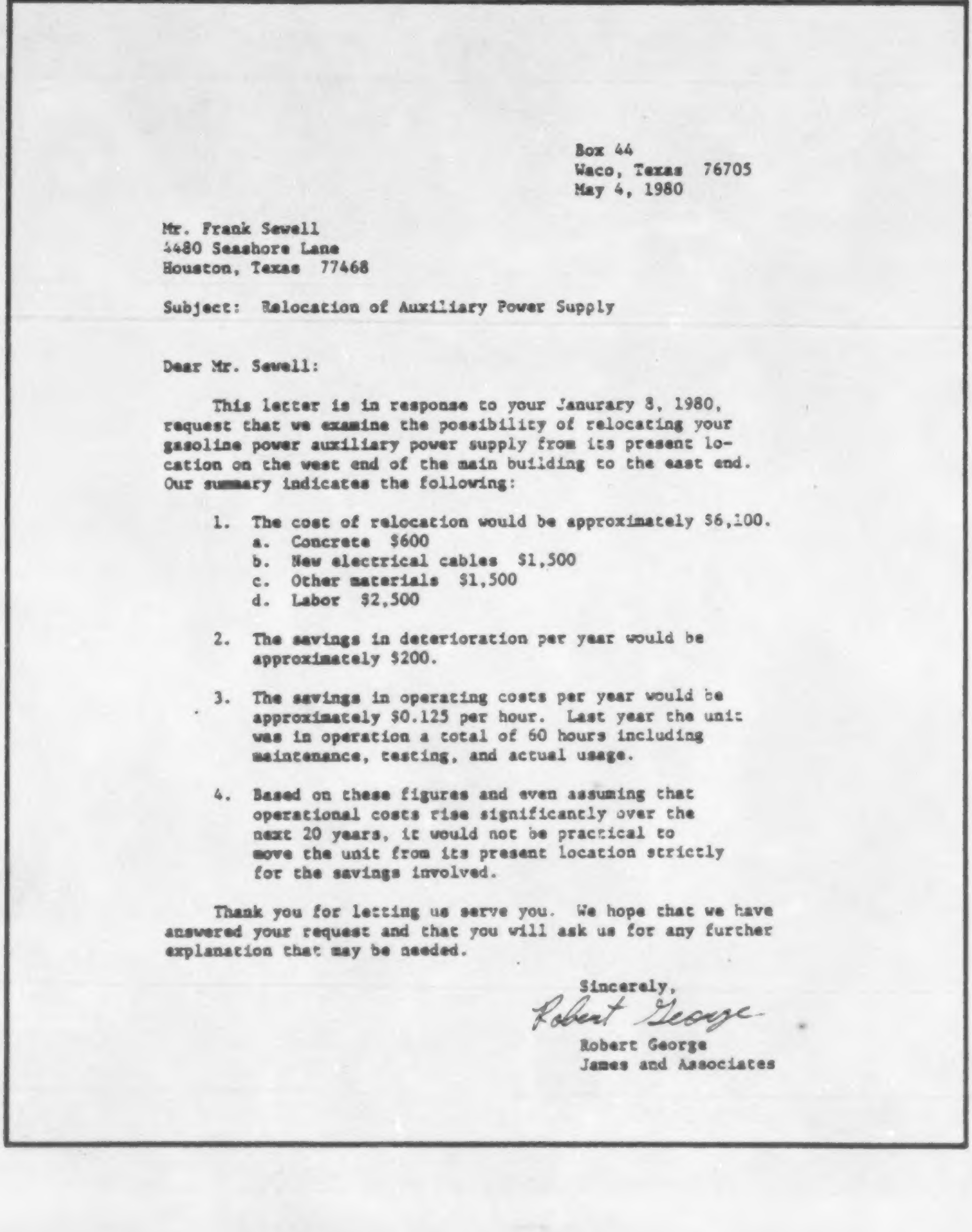
Example F. Continued.

1. "Abstracts on Energy," Abstracts Services, Vol. 20 (April 20, 1980), pp, 30-41.
2. Bent, Alfred. "Regulations and their Impact," Regulation Summaries, Vol. 30 (May 5, 1980), pp. 3-7.
3. Energy Regulations. Washington, D.C.: U. S. Government Printing Office, 1980. Report No. 31-8868-44.
4. Stein, Robert. New Regulations and Their Effect on Housing. Boston: Brown and Company, 1980.
5. "Universal Regulations: Will They Work?" U. S. Energy Affairs, Vol. 3 (May 12, 1980), pp. 20-27.

These sources seem to agree that the effects of the changes are not far-reaching, but regulation III, 1, c will affect our plant in Germany.

Letter reports differ from memos. Memos are normally in-house; letter reports are directed outside the organization. Content may be identical, but form and tone will be different. Format will follow the letter form being used by the technician's company and the tone will have a more personal – or what is often termed the "you" – approach. Example G is an example of an informal letter report.

EXAMPLE G: INFORMAL LETTER REPORT.



Box 44
Waco, Texas 76705
May 4, 1980

Mr. Frank Sewell
4480 Seashore Lane
Houston, Texas 77468

Subject: Relocation of Auxiliary Power Supply

Dear Mr. Sewell:

This letter is in response to your Janurary 8, 1980, request that we examine the possibility of relocating your gasoline power auxiliary power supply from its present location on the west end of the main building to the east end. Our summary indicates the following:

1. The cost of relocation would be approximately $6,100.
    - a. Concrete $600
    - b. New electrical cables $1,500
    - c. Other materials $1,500
    - d. Labor $2,500
2. The savings in deterioration per year would be approximately $200.
3. The savings in operating costs per year would be approximately $0.125 per hour. Last year the unit was in operation a total of 60 hours including maintenance, testing, and actual usage.
4. Based on these figures and even assuming that operational costs rise significantly over the next 20 years, it would not be practical to move the unit from its present location strictly for the savings involved.

Thank you for letting us serve you. We hope that we have answered your request and that you will ask us for any further explanation that may be needed.

Sincerely,
Robert George
Robert George
James and Associates

The third type of informal report is the prepared form. Almost any type of form fits this category. This format probably does not have as much use in reporting research as the memo or letter report, but prepared forms can be used. Forms can be prepared to report periodic activities, to make purchases, to abstract new documents, to apply for a license, to summarize the results of a survey or of a lab experiment, or to report any other project or activity.

A lab report, the most popular informal report, may or may not be on a prepared form. The purpose is to communicate information gathered through rigid research; therefore, the lab report format is usually rigid. Each company has its own format, but most follow a pattern like this:

- Introduction
    - Purpose
    - Problem
    - Scope
    - Apparatus (or equipment)
    - Procedure

- Body
    - Presentation and interpretation of data

- Conclusions

- Recommendations (may not be included)

Some companies require that conclusions and recommendations be placed at the beginning of the report.

Formal reports have an important place in industry, although the technician may not write many. Formal reports provide information that management needs to make major decisions. Although most formal reports resemble college research papers, there are some major differences. The student who has formalized the results of research into term papers following prescribed formats (and made good grades) has learned the secret to making formal reports: follow instructions carefully.

There are three chief similarities between the reports a technician writes and typical college papers. Both follow specific formats. Both research narrow topics. Both attempt to assimilate information from different sources. It is important that the research investigation represent retrieval of data from varied sources; otherwise, the end product is not adequate for use in forming conclusions.

Differences between the typical college paper and the technician's formal report are the following:

- Topic of the technical report is usually assigned.
- Headings are placed within the body of the technical report; items in the table of contents appear as these headings.
- Audience adaptation is imperative in writing the technical report.
- More illustrations are usually incorporated into the technical report than are placed in the typical college paper.
- A more elaborate format is usually required for the technical report. This format includes elements such as a letter of transmittal, a list of illustrations, and/or a list of definitions and symbols.

A formal report attempts to analyze a subject and present findings in a form that can be understood by an audience composed of different types of readers. A modern formal report usually contains the following elements:

- Transmittal correspondence
- Title page
- Table of contents

- **List of illustrations**
- **List of definitions and symbols**
- **Abstract**
- **Introduction**
- **Body**
- **Conclusions or summary**
- **Recommendations (if called for)**
- **Bibliography**
- **Appendix**

Elements are often in the preceding order, but order is dictated by the company.

The first element listed, transmittal correspondence, is either a memorandum or a letter, and directs the report to someone. A memo is commonly used for an internal report. An external or firm-to-firm report calls for a letter of transmittal. A letter of transmittal follows the normal business letter format. The body of the letter does the following:

1. States the titles of the report.
2. States when it was requested.
3. Summarizes the report's purpose and scope.
4. Lists any major problems.
5. Acknowledges any assistance received.

See Example H.

EXAMPLE H: LETTER OF TRANSMITTAL.

The Crest Company
2380 West Drive
Dallas, Texas 75220

May 20, 1980

Mr. John Smith
N. P. Jones Manufacturing Company
2844 Industrial Circle
Dallas, Texas 75283

Dear Mr. Smith:

The attached report, entitled "The Feasibility of Numerical Control Mills," is submitted in accordance with your request of January 10, 1980.

The report examines four basic systems, explaining advantages and disadvantages. The difficulties included (1) locating recent studies, (2) finding accurate statistics, and (3) conducting reliable tests.

The Mark IV is recommended — but with the limitations listed. Suggestions for installation are included. Your maintenance department and the Mark IV testing laboratory staff offered valuable assistance.

Sincerely,
Robert Wesson
Robert Wesson,
Testing Coordinator

Format for the title page of a formal report depends on the company. It should include (1) the title of the report; (2) the name, title, and firm of the one to whom the report is addressed; (3) the writer's name and the writer's firm; and (4) the date.

The table of contents of a formal report lists the contents of the report and where to find each part. It usually only lists the items that follow. All items on the table of contents appear as headings in the report, although all headings in the report may not appear in the table of contents

The company stylebook is the authority, but the method for inserting headings in the report is normally as follows:

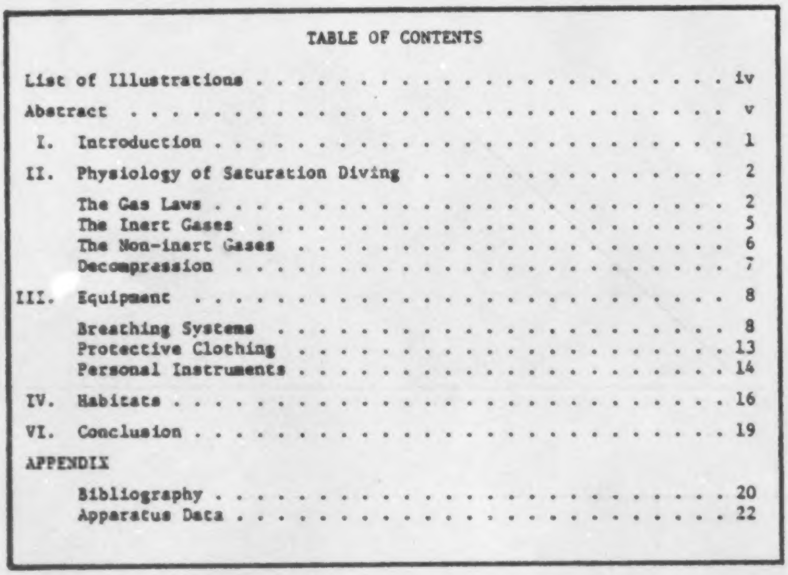
a. First order headings appear at the top of a new page.

b. Second order headings start flush with the left margin on a line by themselves with no punctuation after them.

c. Third order headings are indented, have a period after them, and the first line of the paragraph starts on the same line following the heading.

Formal reports seldom have more than third order headings. Example I follows a rather conventional format; several variations are possible. Example I has only first and second order headings.

EXAMPLE I: POSSIBLE FORMAT FOR TABLE OF CONTENTS.



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    Protective Clothing 13
    Personal Instruments 14
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The list of illustrations in a formal report includes both tables and figures. Some formats require separating tables and figures; others combine them into one chronological list. Some formats call this the List of Figures. Figure number, title, and page number are given. It is assumed, therefore, that each illustration has a number and a title.

EXAMPLE J: FORMAT FOR LIST OF ILLUSTRATIONS.

LIST OF ILLUSTRATIONS

	Illustration	Page
1.	Boyle's Law	4
2.	Open-circuit Scuba	10
3.	Closed-circuit Scuba	11
4.	Umbilical-supplied Breathing System	12
5.	Oceaneering 1,000	18

An informative abstract is short, summarizes the report, and should probably be written last. The writer should use the table of contents as a guide, instead of trying to summarize through reading each part of the actual report; otherwise, the abstract will be too long. See Example K.

EXAMPLE K: TYPICAL ABSTRACT OF A FORMAL REPORT.

ABSTRACT

Saturation diving is a rather new field of study. The word saturation in this field deals with man's ability to absorb and expel the gases that are taken into the body under increased atmospheric pressure. The behavior of all gases is affected by three factors: the temperature, the pressure, and the volume of

Example K. Continued.

the gas. Nitrogen is primarily used to mix with oxygen as a breathing medium, but helium is being used more every day. Oxygen by itself can be poisonous at more than two atmospheres. Decompression is a chief concern to the diver and is a result of the saturation of nitrogen. Scuba, open-circuit, is the most widely-used breathing system, and the wet suit is the most widely-used form of protective clothing. The depth gauge and the watch are the two most necessary items in personal instruments. Diving habitats make saturation diving for extended periods of time possible. The oil industry has made the need for saturation diving economically feasible.

The introduction of the formal report prepares the reader for the report. It contains four main elements: (1) statement of subject, (2) statement of purpose, (3) statement of scope, and (4) statement of plan of development. The statement of subject gives the subject of the report. It may include a definition, necessary theory, history, and other background necessary to prepare the reader.

The statement of purpose is the purpose of the report — not of the items being discussed. The statement of scope reveals the boundaries, limits, or emphasis of the report. The plan of development lists the main points, usually in one sentence: "This report will discuss four areas: _____, _____, _____, and _____."

The following student paper, Example L, exemplifies an introduction containing all four items:

EXAMPLE L: TYPICAL INTRODUCTION TO A FORMAL REPORT.

I. Introduction

Saturation diving is a rather new field of study. The word saturation in this field deals with man's ability to absorb and expel the gases which are taken into the body under increased atmospheric pressure. Research and study in this field became necessary when man ventured deeper into the underwater world and found that he required longer periods of time to accomplish the tasks.

The purpose of this report is to examine the physical laws affecting saturation diving and the equipment and materials currently on the market that permit divers to work at critical depths. The following pages will emphasize the problems and equipment related to Gulf Coast off-shore drilling.

This report will analyze the physiology of saturation diving, the equipment, and the habitats.

The body of the report thoroughly discusses the subject. Headings from the table of contents appear within this section. The body is the heart of the report and its form can vary. The technician should examine other company reports as a style guide.

Conclusions and recommendations of a formal report emphasize the collected data. The reader should not be surprised by these sections. Conclusions and recommendations emerge logically from the report. Numbering conclusions and recommendations makes them more visible to the reader and allows the writer to examine research more carefully. Example M is a student paper.

EXAMPLE M: TYPICAL CONCLUSIONS IN A FORMAL REPORT.

CONCLUSIONS

From this paper it can be concluded that:

1. Sludge is a necessary evil.
2. Careful conscientious treatment and management of sludge are essential to a successful sludge use program.
3. Sludge treated soil can increase crop yeilds above yields achieved by commercial fertilizers.
4. Sludge-use can lower or eliminate commercial fertilizer use on crop lands.
5. Sludge can be used to reclaim marginal lands.
6. Sludge can be safely used from both environmental and health standpoints.
7. Composting, heating, drying, and digestion offer the best stabilization results.
8. Composted sludge offers the advantage of organic content.
9. Buying land outright is probably the best method of obtaining disposal sites because of the 75% reimbursement clause under the EPA law.
10. New stringent laws will force changes in municipal discharge practices.

The bibliography is an alphabetized list of the documents used. The appendix contains subordinate, supplementary, or highly technical information that the writer does not want to place in the body of the formal report.

SUMMARIZING: CONDUCTING AND REPORTING RESEARCH

This discussion of the development of formal and informal reports has been intentionally brief, trying to concentrate only on some of the differences between technical reports and more conventional college papers. The objective here is to review research methods, concentrating on those items that will help the technician.

This module has listed some key aids that will help the technician (1) carry out the preliminary steps; (2) assemble a bibliography; and (3) put the results of the research to the best use. More complete discussions of each phase of the procedure are available both from the sources listed at the end of this module and other similar materials.

EXERCISES

1. Select a technology-related term and have it approved by the instructor. Prepare a list of at least 15 subject headings under which information can be found. Use as many subject heading sources as possible.
2. Prepare an annotated bibliography on a technical subject. The list should contain 20-30 entries, with at least 10 entries from periodicals.
3. Prepare a thorough bibliography on a technical or instructor-assigned topic. Search all guides and indexes available. Put the entries on cards.
4. Prepare a short, informal report suggesting how a longer research project can be conducted and how the formal report can be written. What steps would be taken? What tools would be used?

   The supervisor, Jack Jones, has asked that a thorough study be made to determine the possible effect that lab temperatures of 80 degrees would have on staff performance, equipment performance and maintenance, and energy savings. The lab is now kept at 68 degrees, and he believes that the savings would be worth raising the temperature.

   In this hypothetical situation, the student should determine what equipment is in the lab.
5. Students should examine one index and two abstracting services related to their major. Compare them for —
   a. Scope (What is the extent of their coverage?)
   b. Purpose (Who is the intended reader? What type of questions will they answer?)
   c. Type of information given (What details are included in each entry? How thorough is the entry?)
6. Write an introduction and conclusion to the following short student report on how to start a power lawnmower. Include all four essentials in the introduction. Number the conclusions after beginning with a statement such as,

"From the proceeding report it can be concluded that ..."

This is a short, simple report, but the objective is to gain practice in analyzing the material and writing introductions and conclusions.

> The oil quantity must be sufficient to ensure proper lubrication of all internal moving parts. Remove the oil filter plug located on the base of the engine. The dipstick is built into the plug and will indicate the oil level. Add a good brand of SAE 30-weight oil, if needed. Be sure to replace the oil filter plug.
>
> The second step is to visually check the gasoline level. Add regular gasoline to fill the gasoline tank. Do not spill gasoline on a hot engine or the exhaust muffler.
>
> The sparkplug wire must be firmly attached to the sparkplug. This is very important because the engine will not start if the connection is loose.
>
> The throttle control must be set to the choke position. This position reduces the amount of air in the fuel/air mixture. The richer gasoline mixture greatly assists in initial detonation of the fuel/air mixture in the cyclinder.
>
> The starter rope is pulled to its full length with a steady motion. If the engine does not start on the first pull, allow the rope to rewind and keep repeating the steady motion pull until the engine starts.
>
> As soon as the engine starts, reset the throttle control out of the choke position to 1/2 the throttle position. The engine is now ready to accomplish its tasks.

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TEST

1. List the preliminary steps in conducting research.

2. Define the terms "primary" and "secondary" sources.

3. List four suggestions for conducting an interview.

4. List four steps in assembling a bibliography.

5. List six types of accessing tools.

6. List two sources of subject headings.

7. From the following Readers' Guide entry, identify each part: Featherbedding on the pads. R. Williams. il Time 77:78-9 My 5'61.

8. What is an abstracting service?

9. What is an information center? What services can it provide?

10. List five ways of utilizing the results of research.

11. List four pieces of information that the researcher should include on each note card.

12. What should guide the researcher in writing summaries in an annotated bibliography?

13. List three differences between informal and formal reports.

14. In what three formats do informal reports usually appear?

15. In a formal report, what is the transmittal correspondence? What should be included in it?

16. What is the final authority in the format of a formal report?

ENERGY TECHNOLOGY

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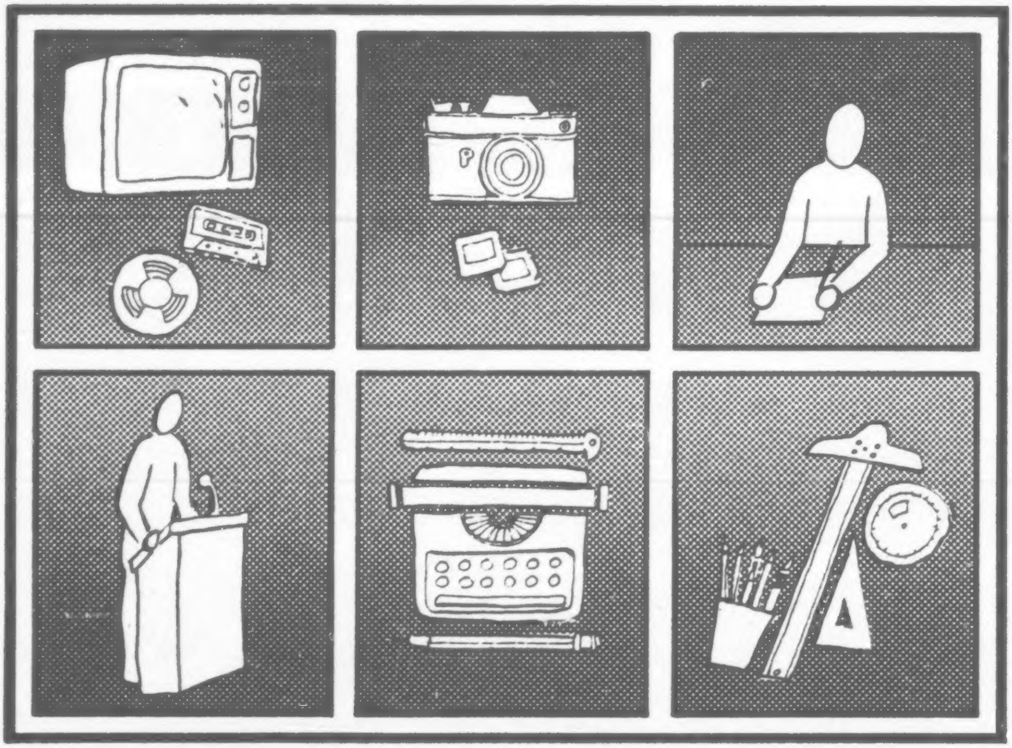

MODULE TC-03

WRITING OUTLINES AND ABSTRACTS

CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

INTRODUCTION

Effective technical communication requires effective planning and summarizing. One key to efficient planning is outlining, but sometimes a student views outlining only as an end product rather than as a tool for rapid planning. The same student may not realize that writing abstracts and introductory summaries are normal parts of a technician's duties.

This module will examine how to use outlines and abstracts as planning and summarizing tools. The student will receive instructions and suggestions and will practice several techniques.

PREREQUISITES

The student should have completed the first module in Technical Communications.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. Explain for whom an outline is prepared.
2. Explain the statement, "no point – no plan."
3. Explain the statement, "An outline is a tool, not an end in itself."
4. Explain how an outline is used to sketch a plan.
5. List two major advantages of outlining.

6. List and explain five suggestions for devising an outline.
7. Compare topic, sentence, and paragraph outlines.
8. Show how outlining follows the principles of math.
9. Use the Roman/Arabic System.
10. Define an abstract.
11. Compare descriptive and informative abstracts.
12. List five suggestions for constructing abstracts.
13. Construct an accurate outline.
14. Write both descriptive and informative abstracts.

PLANNING AND SUMMARIZING

Although most of the modules from this course on technical communications give instructions and practice on "how" to communicate, one of the most difficult tasks a technician faces is planning "what" to write or say. For instance, what is the main purpose of a report? How should the analysis be organized? What should be included in a letter? What areas should a presentation cover?

To help the technician answer these and related questions, this module will suggest ways to use professional planning, summarizing, and abstracting methods that benefit the reader and the writer. This module will be organized under these headings: "Outlines" and "Abstracts and Introductory Summaries."

OUTLINES

One of the communicator's best planning tools is the outline, but only if the writer or speaker outlines practically and efficiently. An outline must be a means toward an end and not the end itself. Producing a beautiful outline is not the objective. Usually, no one but the technician will see the outline. Even if the outline is to be distributed, the preliminary copy is not the one others will see.

Sometimes an outline may be intended for another person (the reader) but most outlines are prepared for the communicator's use. The first portion of this module will cover outlining for private use; then a few suggestions will be given for preparing outlines for distribution. Even though some outlines are written for distribution, outlining is primarily used to plan before one begins to write.

NO POINT – NO PLAN

Until the purpose of the report, presentation, analysis, letter, or other item is determined, it is a waste of time to work on an outline. In other words: no point – no plan. Why is the report being written? What is the presentation's purpose? Why is the reader being given the information? When these questions are answered, the communicator can construct a plan. The writer must decide "what" to say and "how" to say it: the purpose is the "what"; the outline is the "how."

For instance, the writer may be describing how to solder. Is this intended to be a set of instructions or is the description intended to give only general information? Perhaps the technician plans to describe a heat pump as a part of a larger report. Is the description general information, or will the reader use the description to identify all the parts of the heat pump as part of a repair procedure? Maybe instead of "no point – no plan," the axiom should be "vague point – confusing plan."

OUTLINING EFFECTIVELY

Armed with a specific purpose, the technician's next job is to devise a plan. Planning the presentation of information ordinarily requires outlining. Although some of this module will explain the fundamentals of outlining, the communicator should always remember that the outline is a tool and not an end in itself. Perhaps too much concentration on correct form and numbering systems has given outlining a bad reputation. The technician should remember that the most important outlines are seen only by the people who make them. An outline may be in the margins of rough drafts or even on the back of another item. Outlines may be in any form or combination of forms. In the final analysis, it is not important how the outline looks. What is important is that the technician make some kind of outline before writing or speaking. Much time can be saved if this procedure is followed.

An outline has two major advantages. First, the outline is a planning tool. Outlining allows a writer to devise, work out, accept, or reject alternate plans for structuring materials. A poor plan can be dropped before materials are prepared; a good plan can be solidified and improved.

It is time-consuming to write several complete reports to determine which organizational method is best. An outline can be reviewed, changed, thrown away, or refined; time spent is still less than the time required to write a rough draft.

In addition to allowing the communicator a chance to plan an item before actually composing it, outlining has another important advantage. Outlining imposes control on the technician. Outlining is a limiting device and, therefore, helps keep the writer or speaker on the subject. With a well-organized outline as a guide, the speaker or writer is less tempted to wander off into interesting — but distracting — stories or details. Although an outline is flexible, it limits material and guides composition. As a blueprint for a house can be changed during construction, the builder, like the writer, has at least dealt with some problems while designing the blueprints.

To summarize, outlining (1) saves time by helping avoid false starts and (2) provides discipline for the technician during a communication assignment.

STEPS IN OUTLINING

The following suggestions for constructing an outline may prove helpful:

1. The technician should develop the habit of mentally outlining an assignment. This is often called brainstorming. If a building is to be repaired, what steps must be taken? What are the substeps? If a technique must be described for an audience, which aspects must they understand? Into which categories do the aspects fall? Can aspects be grouped?

   What is brainstorming? To brainstorm, a person writes down every idea on a subject as each idea appears, avoiding any attempt at evaluation or organization. Ideas are allowed to "cool off" before being evaluated and organized. This cooling off period permits the writer's subconscious mind to work on the ideas; the communicator is usually surprised by how well brainstorming and a follow-up can work. It is a mistake to have one's mind made up too early on how to organize an item of communication. Even the simplest plan can stand a little cooling. Remember — outlining is a tool for determining "what" and "how" before actually constructing the material.

The technician usually employs a modified form of brainstorming. True brainstorming means starting from scratch. For the technician, research has probably been done and information has probably been gathered. At this stage, brainstorming means sitting down with all information, making a list of all items (some will be briefly summarized for this stage), and adding ideas. These "added" ideas may be previously-known facts, nice-to-know information, analogies that explain or illustrate, thoughts about the audience, or other related items. No attempt should be made to evaluate ideas; evaluation comes after the cooling off period.

2. After brainstorming, the technician should set the ideas aside and work on other projects. When unevaluated information is again pulled from the file, the technician will be surprised at the solutions and ideas that will suddenly appear. Usually, the more unrelated the next project is to the one for which the outline is being made, the more solutions one's subconscious will have devised.
3. The next step is to tentatively order the material. One method is to determine which ideas are major divisions and which are subdivisions. Next, group all subdivisions under appropriate major headings. Finally, arrange each major division with subdivisions, in whatever order seems appropriate.

For instance, if building improvements and repairs were needed, necessary changes might first be listed during a brainstorming session. Next, items might be grouped under three main headings: I. Structural Deterioration, II. Cosmetic, and III. Energy Improvement. It might then be decided that improvements and repairs to stop structural deterioration should have first priority. Those ideas dealing with energy improvements might be assigned second priority, and cosmetic ones, last priority. Following the grouping into three main headings, specific ideas can be listed under each category.

The above method of imposing tentative order is the most common. An innovative method has been suggested in which all ideas are randomly written on a sheet of paper. Major ideas are put in boxes and minor ones placed in circles. Introductory ideas are placed at the top, and ending ideas placed at the bottom. Then, a tentative order is imposed by drawing arrows from one item to the next. The result might look something like Figure 1.

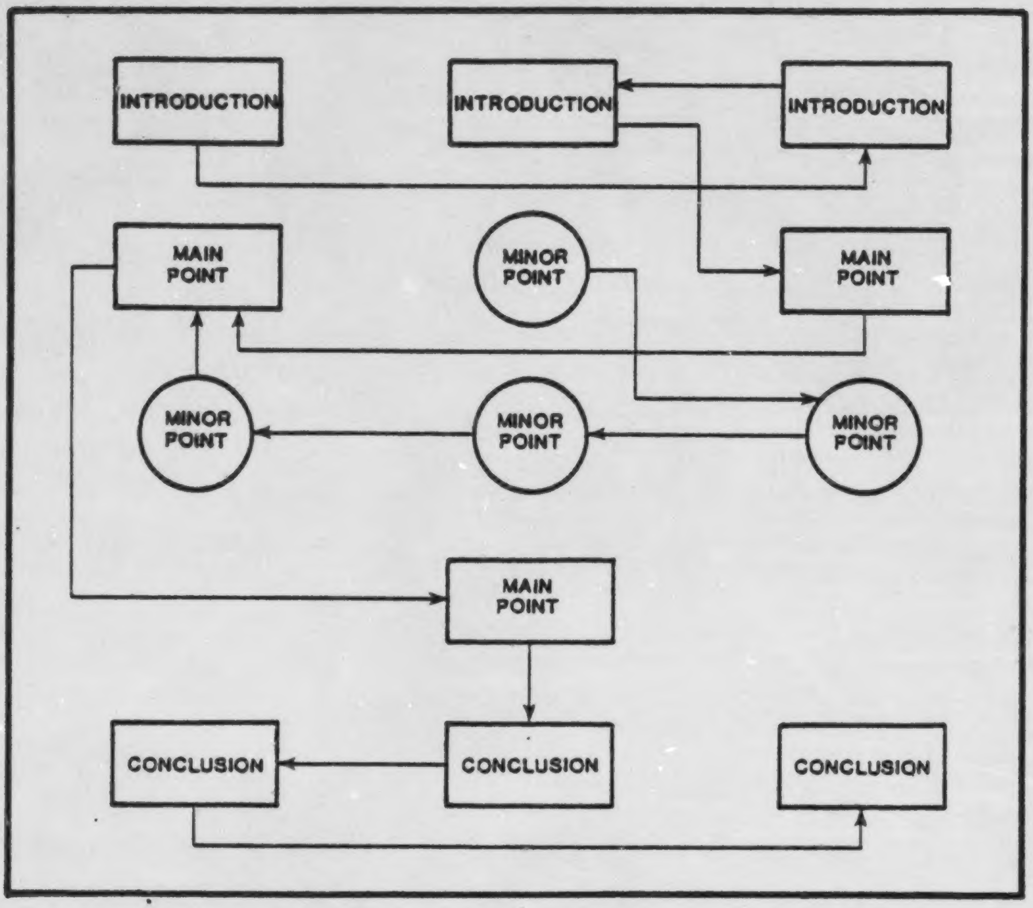
INTRODUCTION
INTRODUCTION
INTRODUCTION
MAIN POINT
MINOR POINT
MAIN POINT
MINOR POINT
MINOR POINT
MINOR POINT
MAIN POINT
CONCLUSION
CONCLUSION
CONCLUSION

Figure 1. Technique of Imposing Tentative Order Through Box and Circle Method.

After determining the best tentative order using this box-and-circle method, the items should be placed in the usual linear form, as follows:

- I. Introduction (thesis sentence)
  - A. First Main Point (briefly)
  - B. Second Main Point (briefly)
  - C. Third Main Point (briefly)
- II. First Main Point (expanded)

III. Second Main Point
    A. First Minor Point
    B. Second Minor Point
    C. Third Minor Point
    D. Fourth Minor Point
IV. Third Main Point (expanded)
V. Conclusion

Other methods have been suggested for tentatively arranging ideas, but most methods fall into one of these two categories. The technician should always look for the method that best suits the writing situation.

4. The outline should be regarded as a tentative plan. At some point, the technician has to stop playing with the outline and begin writing. Usually, the more time spent experimenting with the outline, the more time saved when the report, presentation, or analysis is put on paper.

Even though much time has been spent on the outline, the plan should be changed if the technician discovers – in the middle of writing – that a point should be changed from one position to another. The outline should be strong enough to guide construction of the document and flexible enough to allow revision and refinement.

RULES FOR FORMAL OUTLINES

Now that this module has presented suggestions on how to outline ideas, a few rules for constructing formal outlines are necessary. So far, emphasis has been on outlining as a personal organization guide to thinking, writing, and speaking. In some instances, the technician will prepare an outline for distribution (preliminary plan for a project, outline for a report, the skeleton of an oral presentation), and the outline will need to follow certain standards. Some of these standards have been stated or implied in this discussion, but re-listing them here may help.

1. A formal outline may be a topic outline, a sentence outline, or a paragraph outline. In a topic outline, each entry is a phrase or a single word; no entry is a complete sentence. In a sentence outline, each entry is a complete sentence. The paragraph outline is of virtually no use to a technician and, therefore, will not be discussed.

   Although both the topic and sentence outlines are useful to the technician, the topic outline is usually a more practical guide to writing and speaking. A topic outline is quicker to construct, easier to manage, and more flexible.

   A sentence outline requires the communicator to think out each entry when this is desired. A topical outline entry might say "Equipment"; whereas, the sentence outline would say "The equipment needed includes soldering iron, rosin-core solder, heat sink, and needle-nosed pliers." The sentence outline is most useful in analyzing the writing of others and probably least useful in preliminary planning. In the following examples, Example A is the introduction to a topic outline. Example B is the same introduction in sentence form.

EXAMPLE A: TOPIC OUTLINE.

I. Introduction
    A. Flies and mosquitos as vehicles of infection for eight widespread diseases
        1. Flies
            a. Mechanical transmission of disease
            b. Intestinal diseases they transmit
                (1) Typhoid
                (2) Paratyphoid
                (3) Dysentery
                (4) Cholera
                (5) Hookworm
        2. Mosquitos
            a. Transmission of disease by biting
            b. Diseases they transmit
                (1) Malaria
                (2) Yellow fever
                (3) Dengue

EXAMPLE B: SENTENCE OUTLINE.

I. The fact that flies and mosquitos transmit eight diseases makes it important that these insects be destroyed.
    A. Flies transmit five intestinal diseases.
        1. Flies are mechanical carriers of diseases.
        2. They transmit typhoid, paratyphoid, dysentery, cholera, and hookworm.
    B. Mosquitos transmit three diseases.
        1. Mosquitos transmit by biting.
        2. They transmit malaria, yellow fever, and dengue.

2. Outlining follows the principles of math in that the parts (the divisions) make up the whole (the title or subject). Mathematically, this concept might be expressed this way:

   Subject = Section I + Section II + Section III

   or

   Section I = Subdivision A + Subdivision B

   Very simply, this means that if the parts of an outline do not include all parts that the title indicates, more parts should be added or the title changed. The title, "Steps in Testing an Integrated Circuit," signals the reader that all steps for testing all integrated circuits will be listed. If all steps are not included, a more accurate title might be "Main Steps," or "Steps in Testing a MC 438 Integrated Circuit."

   Most authors say an outline should "cover the subject." The technician should remember that, in this case, the subject is the title. Both the title and outline may be adjusted to fit the technician's purpose. But in all cases, parts should equal the whole.

3. A major division (I, II, III, etc.) does not have to be subdivided. If a division is subdivided, there must be at least two subdivisions. There may be three or six divisions – but not one. Nothing can be divided into one part.

EXAMPLE C: CORRECT AND INCORRECT METHODS OF OUTLINING.

CORRECT:

I. Introduction
    A. Key parts
    B. Minor parts
II. Key Parts
    A. Part one
    B. Part two
III. Minor Parts
    A. Part one
    B. Part two
        1. Subpart one
        2. Subpart two

INCORRECT:

I. Introduction
    A. Key parts
    B. Minor parts
II. Key Parts
    A. Part one
III. Minor Parts
    A. Part one
        1. Subpart one

In the incorrect example, sections II and III were divided into only one part. In addition, III:A was divided into only one part. Nothing can be divided into less than two parts.

4. A logical, consistent system of numbering and indenting topics should be used. The most common is the Roman/Arabic system, which looks like this:

EXAMPLE D: COMMON SYSTEM OF LABELING OUTLINE PARTS.

```
I.
    A.
        1.
        2.
    B.
        1.
        2.
            a.
            b.
                (1)
                (2)
                    (a)
                    (b)
```

Another system that is often used is the decimal form:

EXAMPLE E: DECIMAL FORM OF LABELING OUTLINE PARTS.

```
1.0
    1.1
        1.1.1
        1.1.2
    1.2
        1.2.1
        1.2.2
            1.2.2.1
            1.2.2.2
                1.2.2.2.1
                1.2.2.2.2
    1.3
2.0
```

The writer may or may not skip a line between major divisions, but consistent spacing should be used throughout the outline. Each indention is usually five spaces; indentations should be consistent, regardless of the number of spaces indented. Whatever form of spacing, indentation, and capitalization is used should be the same throughout the outline.

5. Each heading in the outline should be specific, and the words chosen should be as descriptive as possible. Under the heading "Heating Supply Problems," a subheading entitled "Fuel" would say little; whereas, "Fuel Supply Problems" would be clearer. Under the heading "Effects of Strip Mining," the subheading "Permanent Land Scarring" would be more descriptive than "Effects On Land."
6. All items of equal importance should be parallel, or equal, in grammatical form. For instance, in the following outline headings, subdivisions could be gerunds or infinitives, but not a mixture:

EXAMPLE F: OUTLINES USING GERUNDS AND INFINITIVES.

CORRECT — USING GERUNDS:

I. Reasons for proper maintenance
    A. Extending life of the engine
    B. Satisfying warranty requirements
    C. Providing proper temperatures

CORRECT — USING INFINITIVES:

I. Reasons for proper maintenance
    A. To extend life of the engine
    B. To satisfy warranty requirements
    C. To provide proper temperatures

Example F. Continued.

INCORRECT (NOT PARALLEL) — USING MIXED GERUNDS AND INFINITIVES:

- **I. Reasons for proper maintenance**
    - **A. Extending life of engine**
    - **B. To satisfy warranty requirements**
    - **C. Providing proper temperatures**

The technician should remember that formal outlines are for others to see. Most of the time, outlining is a personal tool used to plan what will be written or spoken. One should remember that an outline is a tool, not an end in itself. The technician should not let these remarks on formal outlining obscure outlining's real usefulness — a guide to thinking, writing, and speaking.

ABSTRACTS AND INTRODUCTORY SUMMARIES

"An abstract is a short description, or condensation, of a piece of writing," says one authority. Most other authorities agree. Abstracts are one of the technical communicator's most useful tools. Abstracts are also one of the more difficult writing forms to construct. A technician who can write an accurate abstract can usually handle any writing assignment, for summarizing technical material — without changing the material's emphasis — is a test of one's communicative skill.

An abstract's purpose is usually to save the reader's time. Only the table of contents of a report gets more attention than the abstract. Whereas an outline may be either for the writer or the reader, the abstract is definitely written for the reader.

A short abstract at the beginning of an article or chapter allows the reader to determine if the abstracted material will be useful. An indexed list of short abstracts gives the reader an overview of a large subject area. An abstract of a report may tell the uninformed reader all needed information. An executive or manager may judge the total report (and the person who prepared it) by the abstract. An abstract is often prepared for a report or paper that is to be presented orally. In addition, most journals require that all articles be preceded or accompanied by an abstract.

As stated earlier, an abstract is a summary, condensation, or boiled-down account of a longer document, film, or oral presentation. It can be part of a longer document or it may be considered an end product. Regardless of its relationship to other material, an abstract can normally stand alone.

TYPES OF ABSTRACTS

Abstracts are usually classified as either descriptive or informative. The descriptive abstract tells what the document or report contains, but gives little information about any topic. It is a preview of the text, but does not contain any of the content of the main text. An abstract is easy to write because it is simply a list of the material contained in a document (written in paragraph form).

The informative abstract is often called an introductory summary if it appears at the beginning of a report.

(The final summary is somewhat different, and will be discussed in another module.) The informative abstract is often referred to as a summary, because it gives the essence of a document or presentation and includes most of the significant material. Sometimes called "the report in miniature," the informative abstract repeats the main ideas and the important conclusions, without supporting evidence. The informative abstract says what the text says, but in a highly-condensed form. Whereas the informative abstract usually varies in length (depending on the length of the report), the descriptive abstract tends to be standard length. The informative abstract tends to be five to ten percent of the length of the body of the report. Usually, the company for which the abstract is being written will set maximum length limits.

Here are some examples of descriptive and informative abstracts. Notice that both abstract types list the topics covered, but the informative abstract gives essential details.

EXAMPLE G: DESCRIPTIVE AND INFORMATIVE ABSTRACTS.

DESCRIPTIVE ABSTRACTS:

- Major diseases that are hazards in isolated research stations can be prevented by removing or destroying the breeding places of flies, mosquitos, and rats.
- This report contains suggestions for successfully soldering stranded and solid copper wire and copper tubing. Two methods are listed for testing the resulting connection.

Example G. Continued.

INFORMATIVE ABSTRACTS:

- Major diseases that are hazards in isolated research stations can be prevented by removing or destroying the breeding places of flies, mosquitos, and rats. The breeding of flies can be controlled by properly disposing of decaying organic matter. The breeding of mosquitos can be controlled by eliminating pools or spraying the surface with oil. For rats, only indirect methods of building rat-resistant buildings and protected food supplies have much effect.
- Effectively soldering both stranded and solid copper wire and copper tubing is simple if a few rules are followed. The connection or joint should be properly cleaned and possibly fluxed. The joint should be heated and the solder applied. The connection can be tested using either force or an ohmmeter.

One of the briefest abstracts is the annotated bibliography entry. The annotated bibliography not only lists a number of sources, it also gives the reader some information about the source. This brief abstract can be either descriptive or informative. This type of bibliography can be a real time-saver, for it gives the reader a quick overview of the materials available. The technician should note in reading and in writing annotations that, unlike other abstracts, the annotated bibliography does not have to follow the order of the source; an abstract entry may be only a key phrase that characterizes the material or points out the material's significance.

EXAMPLE H: DESCRIPTIVE AND INFORMATIVE ANNOTATED BIBLIOGRAPHIES.

DESCRIPTIVE ANNOTATION:

Doe, John. Methods of Attachment. New York: Brown and Company, 1976.

The main methods of attaching metal strips to large storage tanks.

INFORMATIVE ANNOTATION:

Doe, John. Methods of Attachment. New York: Brown and Company, 1976.

Strips can be attached to storage tanks using screws, bolts, or solder, depending on purpose of strips. Tanks storing petrochemicals should be treated using four methods.

SUGGESTIONS FOR WRITING ABSTRACTS

Here are a few suggestions for constructing effective abstracts:

1. The material being abstracted should be as organized as possible. This allows simply summarizing the major divisions of the material. It may be a good idea to write the abstract using the outline or table of contents; this method helps prevent getting tangled up in details.
2. In preparing to abstract a source, underlining the key ideas in the material can help bring together the document's content.

3. The first sentence in an abstract should focus on the main idea of the item being summarized.
4. After the beginning sentence is constructed, each additional sentence should develop or contribute to the main idea stated in that first sentence.
5. Usually, an abstract is a single sentence. A special effort should be made to avoid highly technical language because the abstract is intended to be a summary for a wide audience.
6. The abstract, as stated earlier, should be thought of as a completely independent unit, intelligible without need to refer to the source.

SUMMARY

In conclusion, remember: A beautiful outline is not the technician's objective. Outlining is a planning method and not an end in itself. In writing abstracts, one must preserve the essence of the document. An abstract is not an evaluation or a comment – it is a summary. It may be descriptive or informative, but it must be an unbiased summary.

EXERCISES

1. Prepare a one-page topic outline of this module.
2. Plan a report on how to repair a mechanism. Prepare an outline that could be used to write the report.
3. Prepare a checklist that would be used to check off maintenance steps on a piece of lab equipment.
4. Write a descriptive and an informative abstract of this module.
5. Select a technical article and write an informative abstract of it. The abstract should not be over 100 words. The article should be at least two pages in length. Attach a copy of the article to the abstract.
6. Select six sources (books, articles, pamphlets, and booklets) related to a required course. Use the card catalog and Reader's Guide to find the sources. Prepare an annotated bibliography of these items. The brief abstracts can be descriptive or informative, but they should all be of the same type.
7. Bring a few outlines and abstracts to class that have been published. Be able to comment on their purpose, type, style, and effectiveness.

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TEST

1. For whom can an outline be written? For whom is an abstract intended?

2. Explain the statement, "no point – no plan."

3. Explain the statement, "An outline is a tool, not an end in itself."

4. How can an outline be used to sketch out a plan?

5. What are two major advantages of outlining?

6. Give four suggestions for devising an outline.

7. What are the three types of outlines? Which type is the technician most likely to use?

8. How does outlining follow the principles of math?

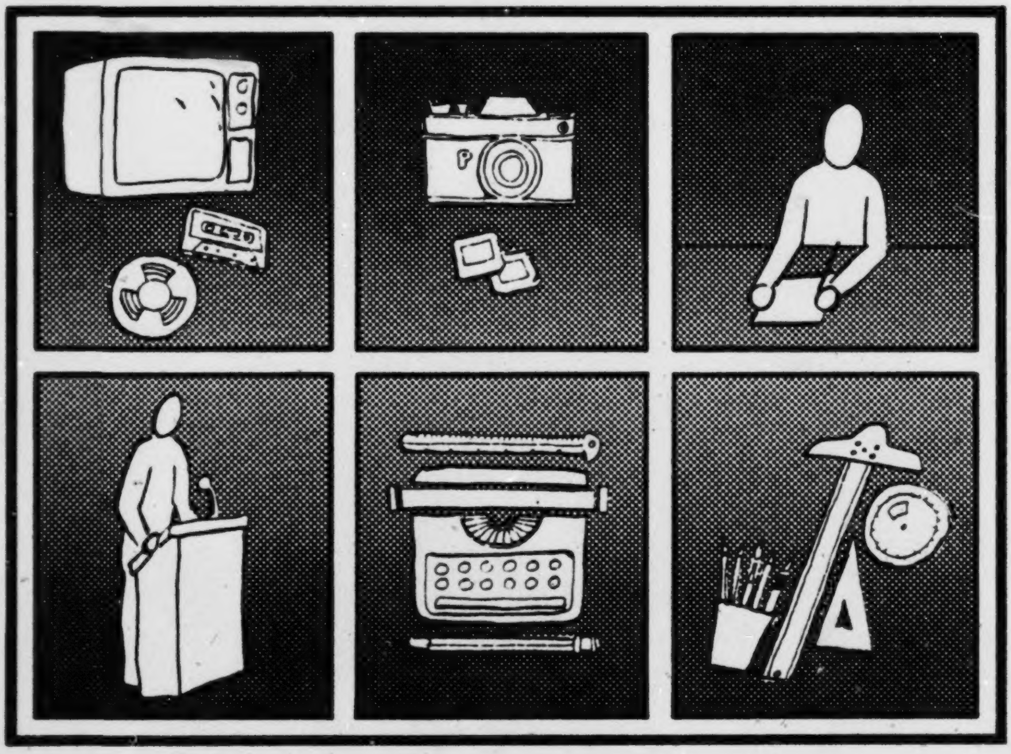
9. What is an abstract? Define two types of abstracts.

10. List five suggestions for constructing abstracts.

ENERGY TECHNOLOGY

CONSERVATION AND USE

TECHNICAL COMMUNICATIONS



MODULE TC-04

WRITING DEFINITIONS

CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

INTRODUCTION

An energy technician must communicate with many types of persons. Having to deal with such varied experience levels means that the technician will sometimes use terms that are unfamiliar to the intended audience. For this reason, effective communication frequently means having to define terms for the audience. Writing definitions, although comprising only a small part of technical communications, requires skill and experience. This module examines what terms should be defined, how definitions are constructed, and where definitions should be placed when used in reports.

PREREQUISITES

The student should have completed Modules TC-01, TC-02, and TC-03 of Technical Communications.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. List, define, and illustrate three types of terms that should be defined.
2. Define informal and formal definitions, explaining when each should be used.
3. Differentiate between informal and formal definitions and be able to construct both types.
4. Explain why definitions must be adapted to the intended audience.

5. Give a few suggestions concerning the following: repeating key terms, using qualifying phrases, and using familiar words in formal definitions.
6. Define and construct an amplified, or extended, definition.
7. List and define at least seven methods for amplifying a definition.
8. List and explain three places a definition can be placed in a report.
9. List and explain three items that determine how long a definition should be.

WHAT SHOULD BE DEFINED

Clarity is critical in technical communication. If a communicator really strives for clarity, then definitions are often necessary. To define a term is to give the term's exact meaning.

In examining the use of definitons, it is first necessary to think about what should be defined. Often a technician will say, "I don't need definitions; I just use the exact word." No one can argue with the validity of this statement, since neither writers nor speakers should use definitions to cover up poorly chosen terms. Long discussions should be avoided in instances when choosing the exact word is the easier solution.

Unfortunately, some words are rather hard to pin down as to exact meaning. Consider "jig," for instance. To a dancer, a jig is a dance. To a fisherman, a jig is a lure; and to a welder, a jig is a stand for supporting pieces to be joined. Obviously, "jig" has several meanings; therefore, a person using this term will need to define it.

"Words" are simply "words." Writers and readers often argue about the meaning of words since they are only labels for objects, not the objects themselves. For instance, when the technician uses a term in a memo or in some instructions, and the worker reads the memo but does not comprehend the term in the same sense that it was intended, both the writer and the reader are in trouble. If the boss says, "burn this letter," meaning "make a copy of it," and the technician sets fire to the letter, the situation is funny only if one is not the technician.

If words sometimes mean various things to different people, the technician must construct definitions when necessary. Effective communication requires effective definition.

What, then, must be defined? Most authorities agree that three categories of words often need defining: (1) familiar words for unfamiliar things, (2) unfamiliar words for familiar things, and (3) unfamiliar words for unfamiliar things. Mills and Walter (see Reference Section) also suggest considering a fourth category — familiar words for familiar things. This last category is included only to serve as a reminder to the communicator to use a familiar word when possible, not to suggest that familiar words must be defined. A definition should be used only when a familiar word is not available.

Must a complex term always be defined? Not necessarily. How, then, does a technician know when a word needs clarification? Basically, a term needs to be defined when there is a possiblity that the audience may not understand its meaning. Understanding is of the utmost importance. Again, understanding necessitates audience adaptation — a subject that has been discussed in several modules. How does the technician know whether the audience will understand the term unless the audience is analyzed? In other words, the intended audience must always guide the technician's thinking.

To repeat, the three categories of words that often need defining are as follows: (1) familiar words for unfamiliar things, (2) unfamiliar words for familiar things, and (3) unfamiliar words for unfamiliar things. Of these three groups, the last is where most definitions are needed. However, all three categories deserve attention.

FAMILIAR WORDS FOR UNFAMILIAR THINGS

Finding familiar words for unfamiliar thing is a special problem for the technician. Rather ordinary words are sometimes given different meanings that may be unfamiliar to the reader outside the technical field. Every field has its own list of such words, called jargon.

For instance, "apron" has a different meaning in each of the following fields: metal working, aeronautic navigation, cooking, and plumbing. A "cheater" is an extention of a pipe wrench to an oilfield worker; it is a special type of cord to a TV repairman. A "jig," as stated previously, means something different to a welder than it does to a fisherman. "Active" and "passive" to a solar technician have to do with whether mechanical means are used to carry heat from the storage area to the living area; whereas, the same terms define aspects of verbs to a writer (see Module TC-01). A "collector," to a solar technician, is a device for collecting heat from the sun, but an electronic technician might think of a "collector" as the output terminal of a transistor. The point is that rather ordinary words often take on new meanings in industry, and the writer or speaker must often define these words for the target audience.

UNFAMILIAR WORDS FOR FAMILIAR THINGS

Unfamiliar words for familiar things should be avoided if possible. If "energize" the heat pump means to start it, then "start" is probably a better word. Depending on the intended reader, "heavy crude oil" might be a better term than "asphaltic oil." Likewise, "wind power" might be a better term than "aeolian." If at all possible, the simpler term should be used – that is, when a simpler term is available. However, if avoiding the unfamiliar word results in a long awkward phrase, then the unfamiliar word should certainly be used. "Nuclear fission" is simpler than saying "the process in which the nucleus of a heavy atom is split into two or more fragments." Similarly, saying "anthracite coal" is simpler than a phrase explaining anthracite coal's meaning.

The technician must decide whether the subject matter demands using unfamiliar words for familiar things. Does the audience understand the term? After this question is answered, the technician can decide if the term should be defined.

UNFAMILIAR WORDS FOR UNFAMILIAR THINGS

Unfamiliar words for unfamiliar things includes most terms that need defining. Most so-called "technical" words fall into this category. A list of specialized terms from any technical field would normally consist of "unfamiliar words for unfamiliar things," and they would need defining. Such terms often have only one meaning. They are not "familiar words for unfamiliar things."

Words such as "geothermal," "lignite," "gasification," "petrochemical," "magnetohydrodynamics," and "refrigerant" are all words that might need defining for a person outside the energy field. These terms are part of the specialized language of the energy technician and, for the nontechnical audience, could stand for unfamiliar things.

Conversely, an energy technician making an energy audit might expect to have to explain certain specialized terms to a plant manager. The fact that the plant manager is also a specialist does not mean that he or she will understand the language of the energy specialist. The specialized terms of one field would be "familiar words for familiar things" to a person in the same field and "unfamiliar words for unfamiliar things" to an expert in another field or to a nontechnical reader.

The following cannot be over-emphasized: the communicator is responsible for (1) knowing the audience and (2) adapting the material accordingly. The technician who prepares the energy audit may be many miles away when the plant manager reads the report; therefore, terms in the report should be clearly defined when necessary.

HOW DEFINITIONS ARE CONSTRUCTED

Now that this module has examined what terms should be defined, it is necessary to look at how definitions are constructed. Definitions are usually (1) informal (a word or a phrase) or (2) formal (a sentence with perhaps an extended, or amplified, definition). The length, or extent, of the definition depends on the purpose of the communication and the knowledge level of the audience.

Sometimes a word or a phrase is enough: "Measure the E input (energy being consumed) as the first step." Other times, a definition may require several paragraphs. How much does the audience know, and how much does the audience need to know? The answers to these questions help determine the length of a definition.

The length of the definition can also depend on the complexity of the term. "Nuclear" is probably more difficult to define than "geothermal" because of its greater complexity. On the other hand, the internal combustion engine may be easier to explain than "passive solar heating" because the intended audience may be more familiar with the engine. The technician should make a definition as brief as possible, while making the definition detailed enough for the purpose, the audience, and the complexity of the term.

As stated previously, definitions are either informal or formal. Some sources say there are three types of definitions, since the formal type can be either a one-sentence definition or an amplified (extended) definition. Whether definitions are classified as two types (informal, formal) or three types (word or phrase, sentence, amplified or extended), they are written the same way. In this module, the author has chosen to classify definitions as informal or formal.

INFORMAL

"Informal," as used here, means that the writer or speaker simply substitutes a familiar word or phrase for an unfamiliar term. However, before the technician can use an informal definition, the audience must be familiar with most aspects of the term being defined. To define a breeder reactor by saying, "Breeder reactors, or reactors that produce more fuel than they use, are similar to nuclear power reactors," would require that the audience have a general knowledge of reactors and, possibly, of other aspects of nuclear power.

Even the following simple informal definition requires that the audience have some knowledge of trees: "The trees behind our house are deciduous; that is, they shed their foliage during the fall."

FORMAL

When purpose, reader, or complexity of the term demands a clearer definition than a word or a phrase, the technician must use a formal definition. Formal definitions can consist of a three-part sentence definition or both the three-part sentence and an extension or amplification, which includes whatever further details the audience needs.

Whereas the informal definition is a flexible, "in-other-words" technique, the formal sentence definition follows a fixed formula or structure consisting of three principal parts: (1) the term or word to be defined (called the species), (2) the specific group or class to which the word belongs (called the genus), and (3) the distinguishing characteristics or features (called the differential) that set this item apart from similar items in the same group or class. Here are some examples. Notice that each definition is a complete sentence.

Term	Class	Distinguishing Characteristics
A transit	is a surveying instrument	that measures angles.
Stress is	an applied force	that tends to strain or deform an object.
A hybrid	is a solar heating setup	that combines both passive and active systems.

After deciding that a term should be formally defined, one must follow two steps: (1) identify the family or class and (2) determine the most outstanding distinguishing characteristic. All this work for one short sentence may seem foolish, but effective communication requires some thought. Putting an idea into as few words as possible is more difficult than constructing a lengthy discussion.

Clear and accurate reports and forms are probably not as difficult to handle as many technicians think; they simply demand extra attention to the one duty that many workers regard as unimportant - writing.

Class

The technician has a term that must be defined in a letter, report, or speech. First, what is its class? The following are some attempts to select the best class, or genus, for a few typical energy terms:

Term	Class
collector	system component
photovoltaic	light-sensitive material
EER	Energy efficiency ratio
fusion	nuclear reaction
fluorine	fuel salt

As the student will notice, each term above could belong to more than one class or group. Picking which term is best, or clearest, for the particular usage will be dictated by the situation. The more specific the class is, the better.

Distingushing Characteristic

The second step is to select the distinguishing characteristic that will best achieve the definition's purpose. The characteristic chosen should apply only to the term being defined. To define "gasoline" as "a petroleum product used as a fuel" would not be adequate because several petroleum products are used as fuels. To define "nuclear reactor" as "a power plant used to produce electricity" would not be choosing the best characteristic, since several types of power plants produce electricity. On the other hand, to say "a nuclear reactor is a power plant that produces energy using plutonium-239 or uranium-235" is more specific.

Summary of Formal Usage

Most of what has been discussed about formal definitions could be summed up with one statement: an accurate, limiting class or group joined with a precisely accurate, distinguishing characteristic will result in a good definition. Sometimes, trying to pick out an "accurate, limiting class or group" and a "precisely accurate, distinguishing characteristic" can be frustrating; but having the boss compliment the report or having a company comment on the clarity of an explanation really makes the struggle worth the effort.

Additional Suggestions for Formal Usage

Before leaving the discussion of formal sentence definitions, three suggestions should be mentioned: (1) do not repeat key terms in a definition; (2) include qualifying phrases when necessary; and (3) choose familiar words for the class and the distinguishing characteristic.

Repeating key terms means making a statement such as "a nuclear reactor is a reactor that..." or "fiberglass insulation is a material used to insulate." Probably the technician would think this advice unnecessary, but examples of such statements are plentiful.

Sometimes a definition is given for a specific purpose. A qualifying phrase should be included to indicate that the term has a special meaning in the particular report: "Insular, as used in this report..." or "hydropower, as defined by the energy commission..." or "energy efficient, as defined in regulation 224b...." Unless the technician tells the audience of such limitations, the resulting definitions will not be clear or accurate.

The third suggestion is to use familiar words in the class and distinguishing characteristic portions of the definition. The communicator should not weaken well-formulated definitions by defining one unfamiliar word with another unfamiliar word. The somewhat simple definition, "hydrocarbons are compounds which contain only carbon and hydrogen," assumes that the audience understands the meaning of carbon. In the definition, "substituted hydrocarbons are hydrocarbons in which one hydrogen atom has been replaced by a functional group," the reader must know the meaning of "functional group." Notice, though, that this definition is an exception concerning repeating key terms. In this case, "hydrocarbons" may be repeated.

AMPLIFIED DEFINITIONS

Even though a brief definition of an unfamiliar term is usually adequate, in some instances the audience may need more information than a word, clause, or sentence can contain. When the reader or listener needs a full understanding of a term, then an amplified – or extended – definition is required.

For instance, the previous definition of substituted hydrocarbons would need to be amplified for an uninformed reader, especially if the reader needed a full understanding of the term. What is carbon? What are hydrocarbons? What is a compound? What is a functional group? Why are hydrocarbons important? Where are they found? What are similar elements? What is the origin of the term "hydrocarbons?" To answer these questions, one would amplify or extend the definition. The following is an example of an extended definition from the course, Fundamentals of Energy Technology:

> Tar sands are sandstone reservoirs impregnated with heavy crude oil that cannot be obtained through a well by conventional means. Two other terms are given to tar sands: "bituminous sands" and "oil sands." The heavy crude oil is termed "asphaltic oil."
>
> The most extensive deposits of tar sands in the world are located in the province of Alberta in Canada. In the United States, numerous small tar sand deposits...were quarried and sold...for paving material used in road construction during the early part of the 20th century.

Although experts do not agree on a method or a set of methods to amplify a definition, an examination of several sources shows that the following techniques are often used:

1. Giving a further definition means explaining for the reader some words in the definition. For example, in the previous illustration on substituted hydrocarbons, "hydrocarbons" might have to be defined.
2. Stating concrete examples is a second amplifying method. This is probably the best method for giving the audience a clear understanding: "Solar cells are used in photographic light meters." Or, for instance, after defining solar heating, one might give examples for American Indians in pueblos storing daytime heat and releasing it at night to clarify the meaning of solar heating.
3. Comparison and contrast technique can relate an unfamiliar word to familiar word. Showing similarities can help the audience visualize: "Splitting an atom by nuclear fission is much like breaking a piece of ice into several parts."
4. Word derivation is the etymology, or history, of the term. "Geothermal" (geo + thermal) means "the heat of the earth." "Lignite" comes from the Latin word "lignum," meaning "wood," and lignite is a soft coal with the texture of the original wood. Although word derivation can be interesting, this method should be used only to aid understanding – not just to impress the readers.
5. Physical description is definitely important as an amplifying method. The audience could not have a thorough understanding of an air conditioning compressor without a description of it.
6. Basic operating principle and analysis of steps or parts are two more useful methods. Explaining the principle of a heat pump and then analyzing the steps in the process can help the reader break the process into understandable parts.

Other helpful methods are as follows: (1) giving the location, or where the object can be found; (2) illustrating cause and effect; (3) drawing a graphic illustration; (4) stating the history and background; and (5) explaining special materials or conditions required for certain items or processes.

Here are two final notes about amplified definitions. First, the length of the definiton should be determined by how much the audience needs, not how much the technician knows. A lecture is seldom in order. Second, an amplified, or extended, definition usually begins with a formal sentence definition. Following the formal definition, appropriate amplifying methods are used as necessary.

WHERE DEFINITIONS SHOULD BE PLACED

To this point, the module has covered what terms should be defined and how definitions should be constructed. The third and final topic for discussion is where definitions should be placed in a report.

There are three possibilities for placement: (1) in the text of the report itself, (2) at the bottom of the page in footnotes, or (3) at the beginning or end of the report in a glossary or list. All definitions should be placed to suit the writer's purpose and to be convenient for the reader. If a report contains only a few definitions, each could be placed directly after the term being defined.

This method is usually convenient for the reader. If there are several terms to be defined, perhaps a separate glossary at the beginning or end of the report would be better.

If the writer is not sure whether or not the reader knows the term, the definition can be in a footnote. Footnotes are usually used in more formal reports. Footnotes seldom appear in items prepared for use within a company.

If there are some terms that the reader must know to understand the report in general, these terms probably should be defined in the introduction. In actual practice, when the technician decides the importance of terms in light of probable knowledge of the audience, placing definitions is usually easy.

EXERCISES

1. List six terms in a selected technology that, to an uninformed person, would be (1) familiar words for unfamiliar things, (2) unfamiliar words for familiar things, and (3) unfamiliar words for unfamiliar things. The final list should contain 18 words.
2. From the list in Exercise 1, select five words and define each in a one-sentence formal definition. Do not use the dictionary.
3. Select one definition from Exercise 2 and amplify it five different ways. Label each way, using the names of the methods explained in this module.
4. Select a term from the selected technology and write a two-page extended definition of the term. Start with a one-sentence formal definition. Use at least seven different methods of amplifying a definition, and label each one in the left margin.
5. Select three terms from the selected technology that have not been used in other exercises. Define each one formally three times: once for a fifth-grade student, once for an uninformed college student, and once for another person from the technology in question. Each definition should be only one complete sentence.
6. Copy 10 definitions from various technical literature sources: books, magazines, journals, manuals, instruction sheets. Beside each of the 10, identify the following: (1) whether it is formal or informal and (2) who the intended reader appears to be.
7. From the same sources used for Exercise 6, make a list of five words that would need defining under certain circumstances.

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TEST

1. What types of terms should be defined?

2. Define informal and formal definitions. Explain when each should be used.

3. List and define the parts of a formal definition.

4. Explain briefly why definitions must be adapted to the intended reader.

5. List and define seven methods for amplifying a definition.

6. List three places definitions can be placed in a report. Explain the reasons definitions might be placed in each place.

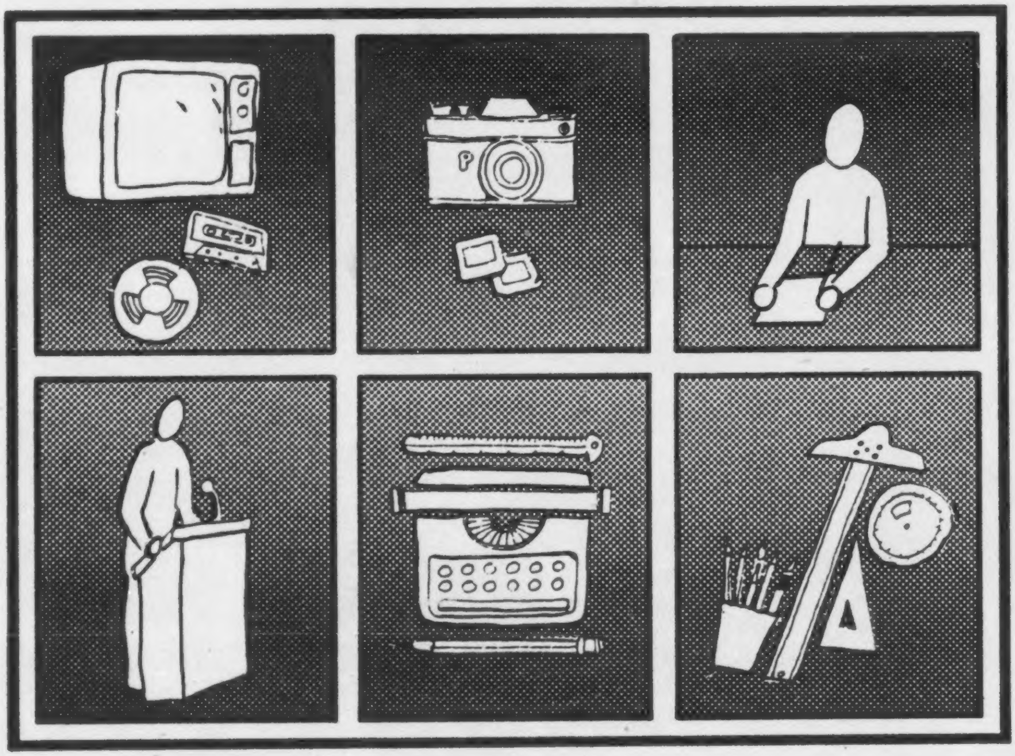
7. List and explain the three items that determine how long a definition should be.

8. Give one brief suggestion for repeating key terms, using a qualifying phrase, and using familiar words in formal definitions.

ENERGY TECHNOLOGY

CONSERVATION AND USE

TECHNICAL COMMUNICATIONS



MODULE TC-05

DESCRIBING MECHANISMS

CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

INTRODUCTION

Technical communications usually include descriptions. To communicate effectively, a technician must describe mechanisms to fellow workers, supervisors, managers, scientists, and the general public.

This module will explain (1) how to construct an effective description; (2) some problems that might be encountered in writing descriptions; and (3) the basics of writing specifications, an area of descriptive writing that requires extreme precision.

The exercises included in this module should further aid the communicator in constructing clear, concise descriptions.

PREREQUISITES

The student should have completed Module TC-01, "Introduction to Technical Communications."

OBJECTIVES

Upon completion of this module, the student should be able to:

1. Define mechanism as used in this module.
2. Explain what "describe a mechanism" means.
3. Explain why a technician might need to describe a mechanism.
4. List the three divisions of a description of a mechanism and explain how each is constructed.

5. Explain the part reader adaptation plays in writing descriptions.
6. List two ways a communicator can create a visual image in the introduction.
7. List two ways the listing of parts can be organized.
8. Explain how to describe parts in a part-by-part description.
9. List eight aspects that should be considered when describing a mechanism in detail.
10. Explain the purpose of the conclusion to a description.
11. Explain how to determine if illustrations are needed.
12. Explain how seeing and communicating affect accuracy of statement.
13. Explain how to determine the amount of detail to include in a description.
14. Define specifications.
15. Explain how specifications can be organized.
16. Describe a mechanism.
17. Analyze a set of specifications.
18. Write a short specification.

DESCRIBING MECHANISMS

A technician constantly works with tools, machines, indicators, and instruments. Often, one of these mechanisms must be described as part of an audit, a bid specification, a repair memorandum, a letter to a manager, an oral report or presentation, a newspaper or magazine article, or a purchase request. Whether a technician performs many writing duties or writes only occasional reports, descriptions will be necessary. The description of the mechanism may be one paragraph or several pages long; principles remain the same, regardless of length or complexity of the description.

"Mechanism" in this module means any device, whether or not it has moving parts. "Description of a mechanism" is clearer than "description of a thing," since "mechanism" is the common technical term given to most items in the industrial world. The technician should keep in mind that, in this context, a mechanism can be anything from a framing square to a solar furnace.

To describe a mechanism means "to represent it verbally" or "to picture it with words." Depending on the subject, purpose, and intended reader, a description could contain the following data:

- Identification of the mechanism
- Function
- Appearance
- Parts and materials
- How the mechanism was assembled
- How the mechanism works

The two principal reasons a technician describes a mechanism are: (1) to give information to a person who will use, buy, operate, assemble, or repair it; or (2) to help someone who needs to know more about the mechanism for some reason. A mechanism can be described in a number of ways. This module will encourage the technician to analyze the situation, the purpose, and the reader each time a description is used. The plan of attack depends, as usual, on the audience analysis. The technician must select details for a description; all details cannot be included. Selected details depend on the audience analysis.

This module will analyze the three components of a description of a mechanism: introduction, part-by-part descriptions, and conclusion. Next, some potential problems will be discussed. Finally, some attention will be given to writing specifications, a special type of description.

Describing a mechanism is seldom a report by itself; the description is usually part of a longer piece of communication. This module is devoted to describing mechanisms because most technical communications contain some descriptions. Usually, these descriptions are simply building blocks in a larger report, letter, memo, set of specifications, or set of instructions. Isolating this technique will give the communicator better opportunity for practice. Still, the technician must remember that descriptions are usually written as part of something else.

What needs to be said in the description depends on what the reader needs to know. The amount of description would not be the same for the reader who wants to build a mechanism as for the person who simply wants a general knowledge of the mechanism. Most experts continually stress audience adaptation in technical communications; audience adaptation is also important when writing the description of a mechanism.

COMPONENTS OF THE DESCRIPTION OF A MECHANISM

Now that this module has examined why descriptions of mechanisms are important to the technician, the next step is to examine how to construct descriptions of mechanisms. Whether a description is brief or several pages long, the description should contain an introduction, a part-by-part description, and usually, a conclusion. It is possible to omit the conclusion, but the description should always have an introduction, even if the introduction and the description are in one paragraph.

The introduction to a description of a mechanism should tell the reader:

1. What the object is.
2. What the object looks like.
3. What its purpose is.
4. What the object's parts are.

The parts and the functions of each part are always important. The complexity of the object and the reader's familiarity with the object help determine length and detail of the introduction. If the description is part of a request to a repairman, the introduction may be only a couple of sentences:

> **The David Model 22 VOM that needs repairing is the 5" x 3" x 2" device currently being used to monitor voltage in the number 4 bay. It has a digital meter, silver plastic case, and banana plug 20" leads.**

If, on the other hand, the same device is being described for a beginning lab student, the introduction will probably be more detailed:

> **The David Model 22 Volt-Ohm-Meter is a compact instrument capable of measuring a.c. 0-1000 volts, d.c. 0-1000 volts, amperage 0-10 A, and resistance 0-100 megohms. The device is 5" x 3" x 2" and is silver with black lettering. The major parts are the case, the digital readout meter, the controls, and two 20" test leads.**

In other words, the description must be written for the audience (intended reader).

The first problem in constructing the introduction is to define the mechanism suitably. If the reader is already familiar with the item being described, all the technician has to do is state the item's distinguishing characteristic. (See Module TC-04, "Writing Definitions.")

A solar technician gives only the distinguishing characteristic when describing a particular brand of heat exchanger to another technician. Defining a window air conditioner to an American audience probably would require only comparing the air conditioner to similar units. On the other hand, defining an oscilloscope for a lab student might require several sentences.

The audience must also know the purpose of the mechanism. Often, the definition indicates purpose. For example, there is no need to explain a flashlight's purpose. Sometimes the name itself gives the mechanism's purpose. Does the name "volt-ohm meter" or VOM really state the purpose of that mechanism? Not totally, because most VOMs also measure decibels and amperage. In some definitions, the statement of purpose can be combined with the definition in one sentence, as shown in a previous example.

Even if the technician thinks the mechanism's purpose is obvious, a brief statement explaining the purpose may help. Writers must remember that they probably will not be present when the readers need them most. The purpose often can be clarified by stating who uses the device, or when and where the device is used. Sometimes, adding why the mechanism is important can also help.

Third, the audience should be given a clear image of the mechanism in the introduction. Drawings and photographs will help, but the technician may not have these illustrations — or such helps may not be necessary.

In the introduction, statements about appearance should be rather general. Major details will come next. An adequate visual image might be created by simply comparing the device with something with which the audience is familiar; for example: "A VOM is about the size of a small portable radio. It has a large dial and several knobs." "The model 28 flashlight is about 1/4 the size of a pack of cigarettes." To a technically-oriented person, the first description might be: "A VOM is similar to a battery checker or a transistor tester."

In addition to comparing the object with a familiar item, the technician might describe the general appearance: "The VOM is enclosed in a plastic case approximately 6 inches long, 5 inches wide, and 3 inches deep."

In some cases, both a comparison and a general description of the mechanism might be used in the introduction, as the following student examples illustrate: "The Lukas 11 AC alternator is very similar to a generator. It is 6 inches in diameter and 6 1/2 inches long." "The Royal model 63 thermostat is 2" x 3" x 1". It is about the size of a pack of cigarettes." Probably, most employers would now require that measurements be stated in both inches and centimeters, which the student writers did not do.

The fourth and last objective of the introduction is to divide the mechanism into parts. It is the technician's responsibility to decide what the largest useful divisions of the mechanism are, to determine in what order they should be described, and to list them in that order. No description is necessary at this time. Major parts should simply be listed in the same order as they will be described in the body (the part-by-part description).

Listing the mechanism's parts in the introduction helps in two ways. First, the list is a way of giving the audience an understanding of the mechanism. Second, the list indicates the order of the part-by-part description. As stated previously, effective technical communication has as few surprises as possible. The list of parts is like a roadmap of the territory to be covered.

The listing of parts or divisions can be organized according to their function or their physical arrangement. For instance, the parts of a basic flat-plate collector, if organized by function, might be in this order: transparent cover, water tubes, absorbing surface, and insulation. If physical arrangement were the basis, the parts would probably be listed from top to bottom: absorbing surface, transparent cover, water tubes, and insulation. See Figure 1.

As a final note, the listing of parts in the introduction can be either a sentence or a list. Here is an example of a sentence:

> The principal parts of a flat-plate collector are the absorbing surface, the transparent cover, the water tubes, and the insulation.

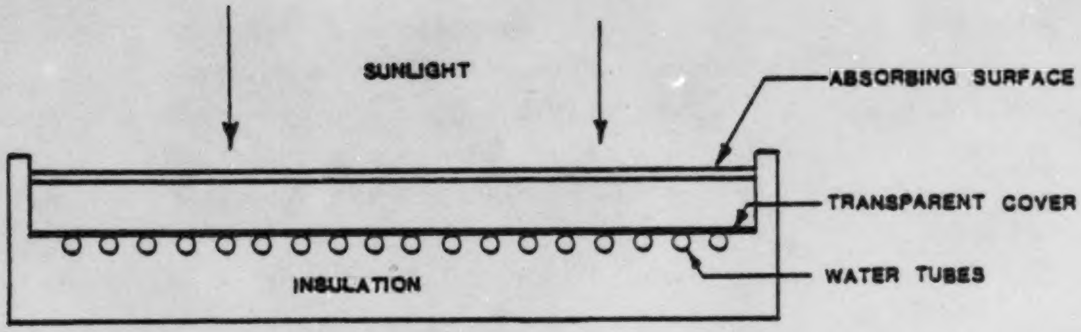


Figure 1. Schematic Diagram of Basic Flat Plate-Collector.

A list might look like this:

> **The principal parts of a flat-plate collector are as follows:**
>
> 1. **Absorbing surface**
> 2. **Transparent cover**
> 3. **Water tubes**
> 4. **Insulation**

The part-by-part description is the second, and most important, part of the description of a mechanism. Whether this section is one short paragraph or several pages long, a part-by-part description is the section from which the reader gets the details necessary to visualize the mechanism. This section is usually written in present tense. The organization is simple: parts are described in the same order as they were listed in the introduction.

The description of each part is also simple. Each component must be handled like a new mechanism, since each part will be unfamiliar to the audience. The technician should introduce the part, state its purpose, indicate its general appearance, and divide it into subparts. For a simple mechanism, this may be all that is necessary. For a more complex component, each subpart can be described in detail.

When describing components, the technician needs to state the purpose of each part and then describe the part in appropriate detail. This is not always easy, for the writer or speaker is often tempted to tell how the object works or to explain the purpose in too much detail. When constructing the descriptive portion of a report, the writer should remember that the purpose is to describe – not explain an entire operation.

The technician's main objective in describing a mechanism is to include sufficient detail for the audience to get an accurate mental picture. Some aspects that should be considered when describing in detail are as follows:

- Color
- Size
- Shape
- Texture
- Position
- Relationship to other parts
- Material
- Finish
- Weight

Each aspect does not need to be treated in every description. Those aspects handled depend on the type of mechanism being described, the purpose of the communication of which the description is a part, and – as always – the reader. Is the description of a boiling water reactor system for (1) a technician who will repair it, (2) an administrator who intends to purchase one, or (3) a lay person who wants to learn more about an unfamiliar subject?

These portions of two student papers show that amount of detail can vary. Neither is a perfect example, but each has merits.

> An Oklahoma Instruments SR-51-II calculator is an advanced electronic computing device. It is slightly larger than a pack of king-sized cigarettes. It may be divided into three parts: (1) the case, (2) the display area, and (3) the keyboard.
>
> The case is black hard plastic. It has grained texture. The case has an overall wedge shape. The bottom of the case is 12 mm long and 2 mm wide. At the point of the wedge, the case is 14.6 mm long and 7.7 mm wide. The top of the calculator is 13.8 mm long and 7.6 mm wide. At the point of the wedge, there is an indention 1 mm deep and 1.5 mm wide that runs completely around the calculator. On the bottom of the case, there are two smooth T-shaped areas.

Obviously, the description is intended for a reader who needs exact dimensions. The rest of the student's description is equally detailed.

Here is the first portion of another student paper. This paper is aimed toward a different audience and written for a different purpose.

> A Renless automatic clothes dryer model 66160 is an electric home appliance that uses hot air to dry clothes. It is a cubical device 34" tall, 34" wide, and 28" deep. The main parts are the body, the lid, the exhaust outlet, and the control knob.
>
> The body is the main part of the dryer. All other parts are attached to it. It is constructed of steel and aluminum and finished in white enamel.

The reader of this nontechnical description can get a general idea of the dryer's appearance; however, the reader of the description of the calculator should be able to draw it to scale. The writer of the first description discussed size, shape, material, and finish. The second student also touched on these four aspects, but did not use as much detail.

The conclusion is the last component in constructing a mechanism. In the conclusion, the technician's responsibility is to let the reader know how the mechanism works, if this is necessary. A conclusion may not be needed. If a conclusion is included, emphasis should be on the relationship between the mechanism's parts. Actually, the conclusion is a condensed description of an operation.

In summary, the description of a mechanism should contain an introduction, a part-by-part description, and usually a conclusion — even though the total description may be brief. In general, the organization will follow a plan as outlined in Example A.

EXAMPLE A: PLAN FOR THE DESCRIPTION OF A MECHANISM.

I. Introduction
    A. Definition of mechanism
    B. Purpose of mechanism
    C. General appearance and comparison with familiar object
    D. Division into principal parts

II. Part-by-part Description
    A. Part 1
        1. Definition
        2. Purpose
        3. Appearance
        4. Division into subparts
            a. Detailed description of subpart 1
                (1) Color
                (2) Size
                (3) Shape
                (4) Texture
                (5) Position

Example A. Continued.

- (6) Relationship to other parts
- (7) Material
- (8) Finish
- (9) Weight
- b. Detailed description of subpart 2 (of 4)
- c. Same as "a"
- d. Same as "a"
- e. Same as "a"
- B. Part 2 (same as "A")
- C. Part 3 (same as "A")

III. Conclusion (brief description of the mechanism in operation).

The technician should realize that this outline is not intended to guide every written description. However, this guide does summarize what has been said. As descriptions are written, both as assignments for this module and as sections of reports, the outline can help the writer decide what approach to take and what details to include. If the writer keeps in mind, "I must give my audience an accurate picture of this object," many aspects that seem problematic will take care of themselves.

SOME POTENTIAL PROBLEMS

Three additional problems in writing effective descriptions of mechanisms are (1) illustrations; (2) accuracy of statement; and (3) amount of detail.

The first problem is: how many illustrations should be used and what should they show? This module cannot answer that question, but here are some guidelines that will help.

Even though illustrations are important, they must normally be accompanied by explanations. A drawing will not usually show an action or how much tension must be applied to a fitting. Also, many persons understand better through reading an explanation than from looking at a drawing. The purpose of the description must be considered. The more the reader needs to know, the more necessary it may be to have illustrations. Is the reader going to work on this mechanism or simply identify it? Responses to these questions and similar question can help the writer decide how many and what kind of illustrations to use.

The second problem is accuracy of statement. At first glance, the technician may assume this means simply choosing the most accurate word. Certainly, word choice is important; the communicator must always seek the clearest term. Accuracy of statement in this situation often involves seeing as the reader sees and communicating what the reader or listener needs to know in order to visualize accurately.

"Seeing" means viewing the object as the intended audience might. It probably goes without saying that the more familiar the communicator is with an object, the more difficult it is to "see" the object as a person unfamiliar with it would. Aspects that another person would find confusing might be missed by the communicator. In describing a fuel pump, a mechanic might not mention the shape; but to a nonmechanic, shape might be one of the first characteristics noticed.

"Seeing" may require that the communicator view the mechanism from several angles before determining which is the best view to picture for the audience. More than one approach may need to be tried. If the reader or listener says, "I cannot visualize this," it makes no difference how clear the description is to the writer. Something is wrong with the description.

First, the technician must see the mechanism as the reader will see it; the next part necessary for accuracy of statement involves communicating with the reader. The technician is expected to use the technical vocabulary of the audience. The meaning should be so clearly stated that the audience gets the exact meaning intended. When communicating with a solar energy worker, the writer is expected to be familiar with and use correct descriptive terms.

But communicating is more than just using the right word from someone's vocabulary. This is a description; the reader or listener must "see" the mechanism after reading or hearing about it. Most authorities agree that the best test is to have some disinterested person attempt to draw the mechanism, using only the verbal description as a guide. This test will help the communicator determine which characteristics need clarifying.

The third problem is deciding how much detail should be included. At one end of the scale is the detailed description of an individual mechanism. The other extreme is the general description intended only to give a fair understanding of the mechanism. The general description attempts to present the mechanism as representative of its class, such as a description of a heat pump, a solar collector, or a gas turbine.

A detailed description might depict a Strator Model 24 heat pump, a Browning solar collector, or a Jensing smooth-flo gas turbine. Normally, the common sense of the writer or speaker will answer questions about how much detail to use. How much detail does the reader want and need? Reader adaptation is always the final guide.

Before looking at some suggestions for writing specifications, it might be helpful to examine a couple of mechanism descriptions, viewing both strengths and weaknesses. Example B is a student paper. Example C is from another module in the energy technician series.

EXAMPLE B: STUDENT PAPER DESCRIBING A MECHANISM.

Lucas 11 AC Alternator

The Lucas 11 AC Alternator is a device that converts mechanical power into electrical power. Its operation is very similar to a generator. This alternator is 6 inches in diameter, and is 6 1/2 inches long. The weight of the alternator is 9 1/2 pounds. It is capable of putting out a maximum current of 45 amperes at rotor speeds up to 12,500 rpm. The alternator consists primarily of two end frame assemblies, a rotor assembly, and a stator assembly.

The end frame assemblies are made of die-cast aluminum. With the frames are bearings that support the rotor. The rotor assembly contains a doughnut-shaped field coil wound onto an iron spool...the coil and spool are mounted between two iron segments with several interlacing fingers. These parts are held together by a press fit on an iron shaft. The iron shaft protrudes through one end of the frame. A pulley is usually connected to this end.

Two slip rings upon which the brushes ride are mounted at one end of the rotor shaft and are attached to the leads from the field coil.

Example B. Continued.

The stator assembly is mounted between the two frame assemblies and consists of loops of wire wound into the slots of the laminated stator frame. It carries 3-phase windings.

Six silicon diodes are mounted in the slip ring end of the frame and are connected to the stator windings forming a 3-phase bridge circuit to give rectification of the generated a.c. output.

The operating functions of the alternator are very simple. A direct current voltage from a battery is connected to the rotor through the brushes that contact the slip rings. A magnetic field is built up around rotor coils of alternating polarities. An external force is applied to the rotor shaft, causing it to rotate. As the shaft rotates, the magnetic field from the rotor cuts the stator winding, thus inducing a current. Because of the alternating polarities of the fields on the rotor, an a.c. current is developed in the stator winding. The current produced then flows through the diodes and is changed to d.c.

This alternator was designed for use on an automobile.

The student writer's introduction contains all necessary elements: definition, purpose, appearance, and list of parts. The definition, calling the alternator a "device," seems aimed for the less-informed reader. The list of parts announces the order in which the part-by-part description will be handled.

A major omission in the student's part-by-part description is the purpose of each part. Even though not much space should be devoted to the purpose of the parts, each should be explained briefly. The end frame subparts are identified but not listed first. The description of end frame subparts explains material, finish, and relationship to other parts, but includes few measurements.

Both the description of the slip ring and the stator assembly are too brief. Few details are included; purposes are omitted. The silicon diodes are described with the assumption that the reader knows how they look and what their purpose is; whereas, the introduction indicates that the intended reader is relatively uninformed.

The final paragraph describes the alternator in operation. The author assumes the reader will understand terms like "magnetic field" and "polarity." Otherwise, the explanation is clear.

In summary, this description is somewhat inconsistent. Either more explanation should be included, or the description should be aimed for a better-informed reader. The author should have stated the purpose of each part, defining those parts that might be unfamiliar to the reader. The author seems doubtful who the reader is intended to be.

Because of the length of the second description, only the first few paragraphs will be quoted. The student who wishes to read the entire example can read it in Module EP-05, "Combustion Engines." Example C is suitable for use in a report.

EXAMPLE C: STUDENT PAPER DESCRIBING A MECHANISM.

COMPONENTS OF AN INTERNAL COMBUSTION ENGINE

The most common type of combustion engine is the reciprocating internal combustion engine, using either gasoline or diesel fuel. This type of engine has the following major components:

Cylinder block
Cylinder head

Example C. Continued.

Intake and exhaust manifold
Valve train
Piston and connecting rod assembly
Crankshaft assembly

CYLINDER BLOCK

The cylinder block is the basic framework of a combustion engine. All other parts are either assembled within it or attached to it. In the block are holes, or cylinders, in which the pistons move. In addition, inside the block are passages for cooling water (in water-cooled engines) or fins that help dissipate heat (in air-cooled engines). The block is normally made from cast iron, a cast iron alloy, or aluminum.

CYLINDER HEAD

The cylinder head is another stationary part of the engine; it is bolted to the block to form a "cap" over the cylinder. There is a head for each bank of cylinders. In-line cylinder configuration engines have only one bank (since all of the cylinders are grouped together) and, thus, have only one head. For a V-type engine, there are two heads. Radial engines do not have cylinders that are grouped together; therefore, they require a head for each cylinder.

The head contains combustion chambers, valve ports, spark plug or fuel nozzle holes, coolant passages, and passages that connect the valves to the manifolds. Because it must withstand the same heat and pressure as the block, the cylinder head is normally constructed of the same metal.

Before the head is bolted to the block, a gasket is placed between these two parts to form a gastight seal. This gasket, called the head gasket, is made of terneplated sheet steel. If the gastight seal is broken, the engine loses compression and power. Fuel consumption also increases. Normally, head gasket leaks make the engine exhaust "pop" because of the improper seal on the exhaust valve. In addition, oil droplets can be seen in the coolant in the radiator and water droplets show up on the oil. Head gasket leaks can only be corrected by replacing the head gasket.

Example C has few flaws and many merits. The author seems to be aiming toward an informed audience who need only a general idea of the mechanism. The introduction is short. It lacks a brief description, but is complete otherwise. The reader is familiar with "combustion" and "reciprocating," since the description is part of a longer discussion in which both terms are defined. The parts are stated in a list, instead of a sentence; this is a common practice for technical reports. The part-by-part description follows the listing order of the introduction.

Description of the first component, the cylinder block, relies on the illustration to show the reader how the part looks. It would be difficult to visualize the block using only the author's words. Although the purpose and materials are mentioned, more details would help.

The second component, the cylinder head, is described only generally. The author's purpose is not to describe a specific head. Much of the description deals with how heads work and how to attach them to the cylinder block.

Other parts are described in much the same way. The author uses only enough detail to give the reader a general view of the part. Quite a bit of attention is devoted to how the part functions.

SPECIFICATIONS

Specifications are a special but important type of description of a mechanism a technician may sometimes be required to write. They are unusual because precision and clarity are crucial. A mistake in this description could cost a company thousands of dollars. If called on to write a specification, the technician must think "accuracy" from start to finish.

A specification is a detailed description of a service or a piece of merchandise that a person or a company intends to purchase. Various types of proposals are based on specifications. The person who prepares a specification is describing exactly how a service is to be performed or an item is to be constructed. Contracts of all types are built around specifications. The most valuable technician is the one who can write specifications, as well as tell the manager what is needed.

The structure of a specification is rather simple and straightforward. First, the writer explains in the introduction what is wanted in general terms. This part states the date when the item or services should be completed and any special requirements that need to be met. Next, the technician writes an individual section for each aspect.

If the specifications are for an experimental solar collector, the introduction explains the dimensions, type of materials, and perhaps exterior finish. The second section, often called the technical clauses, might include sections on excavation, concrete, framing, electrical, glass sections, plumbing, metal work, or finish carpentry. Probably the most common specifications are those written for residences. Residential specifications include sections for many of the same items as the solar collector, plus items such as bathroom and kitchen fixtures and total floorcoverings.

There is no room in a specification for such vague statements as "best quality" or "satisfactory to the customer." The writer must state exactly what is expected and how quality will be judged. Industrial standards should be used when possible, which usually means getting authoritative assistance when needed. Every clause must be thoroughly detailed and technically correct.

The residential specification writer must be specific, yet leave the contractor enough freedom to be innovative; confining the contractor with too many brand names should be avoided. But any published accepted standards of professional groups should be used. If changes can be made later, a concise statement should be made at the end of the specification that gives the technician the right to make such changes.

The technician normally will not be expected to write specifications, but the ability to do so will be useful when the need arises.

EXERCISES

1. Select a mechanism normally used by a technician. Write three descriptions of the mechanism of less than 100 words each. Describe it for (1) a repairman; (2) a new student who will use the item in a lab; and (3) another technician who will look for it among other similar items.
2. Describe a mechanism for an uninformed reader and for a technician who is simply not familiar with this particular item. Each description should be about 200 words.
3. Find descriptions of three different mechanisms in reports, books, magazines, or journal articles. Be prepared to explain each description's organization to other class members.
4. Acquire a set of residential home specifications. Write a 100-200 word paper analyzing the organization, language, and unusual clauses.
5. Write a set of specifications for a small storage building.

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TEST

1. Define mechanism as used in this module.

2. Explain what "describe a mechanism" means.

3. Why might a technician need to describe a mechanism?

4. Outline the three divisions of a description of a mechanism.

5. Explain the part reader adaptation plays in writing descriptions.

6. List two ways a communicator can create a visual image in the introduction.

7. List two ways the listing of parts can be organized.

8. List four aspects that must be considered when describing an item in detail.

9. What should be included in the conclusion, if one is used?

10. How can the writer determine if illustrations are needed?

11. How do seeing and communicating affect accuracy of statement?

12. What determines how much detail to include in a description?

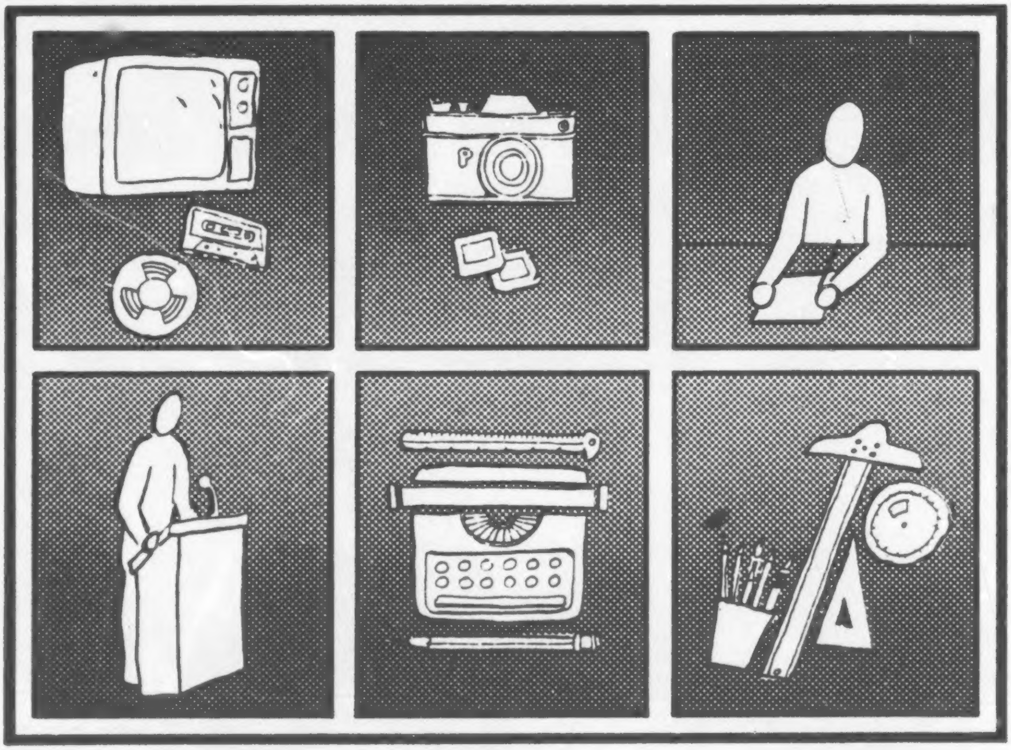
13. Define specifications.

14. How can specifications be organized?

ENERGY TECHNOLOGY

CONSERVATION AND USE

TECHNICAL COMMUNICATIONS



MODULE TC-06

DESCRIBING A PROCESS

CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

INTRODUCTION

Whether the task be explaining how something works, describing how someone performs an operation, or giving instructions, process description is a necessary part of the technician's job. This module defines each type of process description, gives suggestions for constructing each type, and provides methods for checking the students' understanding of concepts.

PREREQUISITES

The student should have completed the introductory Technical Communications module, plus modules on researching, outlining, writing definitions, and describing mechanisms.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. Define a process.
2. List two types of processes.
3. List three problems that arise when describing a process.
4. Know what must be adapted for the audience.
5. Know in which two places the list of materials and supplies can be placed, and in which place lists appear most often.
6. Know how steps or actions are usually organized.

7. List three items that are usually discussed in the introduction and three items that are sometimes included.
8. Know whether or not steps should be divided into substeps.
9. Define and know when to use the imperative mood.
10. Know what determines the amount of detail to include when discussing the steps in a process.
11. Know if a conclusion is needed.
12. List three key differences between a process where no person is conspicuously involved and one in which a person is involved.
13. List seven suggestions for writing instructions.
14. Write descriptions of processes adapted to different readers.
15. Write a set of instructions that a technician could follow.
16. Evaluate instructions.

DESCRIBING A PROCESS

One of the most natural writing assignments a technician will encounter is the description of a process. If a person says, "tell me about the generator," the person spoken to will most likely begin by explaining how it "works," not how it looks.

A process is a series of related actions; therefore, the description of a process is a description of action. The description of a process falls rather naturally into one of two types: one in which a person plays an important part (soldering a wire, charging an air conditioning system, mining coal) and one in which a person plays a minor role (how a T.V. picks up signals, how coal is formed, how a solar collector works). In addition to discussing these two types of process descriptions, this module also includes a section on writing instructions.

Technical communicators must tell others how to do something, explain how something works, or give instructions on how to carry out an operation. The description of a process will usually be part of a longer explanation, report, speech, energy audit, or other activity. Many times, the communicator must explain how something works or how to perform a task, even though the purpose of the report, speech, study, or diagnosis is entirely different.

The purpose of this module is (1) to define description of a process, (2) to examine three problems in describing processes, and (3) to analyze types of processes and their organization. The previous paragraphs have defined the description of a process as a chain of action leading to a desired result.

Usually, this process description involves a mechanism. Here, the word "mechanism" includes all systems whose parts operate in a definable way. Therefore, the description of a process, whether its purpose is to tell how something works or how to perform some task, involves describing a series of actions that usually involve a mechanism.

PROBLEMS ENCOUNTERED IN DESCRIBING A PROCESS

What problems can arise in describing almost any process? The main ones are (1) adaptation to the reader, (2) overall organization, and (3) use of illustrations. Naturally, the most important problem, as with most phases of technical communication, is adapting the process description to the audience.

How much does the audience need to know? Will the description be used as a guide for performing an operation, or is it simply to give a person a general knowledge of the process? Is this description a set of instructions for installing energy efficient lights, or is it only to acquaint the reader with how easy the job can be? The question, "how much does the audience need to know?" is dependent on an audience analysis, which might not take long, but must be done. Language must be adapted. Audience analysis determines writing level. How informed is the audience? What terms must be defined?

The next problem, organization, is really not much of a problem. Steps are usually described in the order they occur. The difficulty is in where to discuss equipment and materials, and this is usually only a problem when writing instructions. Equipment and materials can be lumped together at the beginning, or each item can be discussed as it comes up in the description. If there are only a few items involved, or if all items must be assembled before beginning the process (as in assembling an electronic kit or baking a cake), then the materials are usually listed in the beginning.

If, on the other hand, items are so numerous or complex that remembering them is a problem, they are explained as they appear in discussion. Explaining items as they appear in the text is more common, but both methods are used.

Audience analysis, the importance of having materials available during a process, and number of items are all important considerations when selecting the best place for materials and equipment.

The third problem, use of illustrations, is a difficulty only in trying to include as many clear illustrations as possible. To picture an action is difficult, but this problem can be handled in several ways. Methods are as follows:

1. Provide a series of drawings or pictures showing the technician or the mechanism in various stages.
2. Provide a sketch of how the parts fit together.
3. Illustrate how to hold the tools.

A person unfamiliar with the process is the perfect tester for the illustrations. What questions arise? What is difficult to understand?

TYPES OF PROCESSES

To be able to write descriptions of processes, the technician needs to be familiar with the two types: (1) those in which a person plays an important part and (2) those in which a person does not play an important part. As stated earlier, instructions are a special category of the first type of process description. Because of their importance to the technician, this module will cover writing instructions in detail.

Description of the process involving a person is called several names by different authors. One calls it the "how I did it" description; another says it is the "process in which the operator takes a conspicuous part." Most authors simply call the procedure a description of a process. Regardless of what this technique is called, emphasis is on the person rather than the mechanism.

The description of a process, regardless of type or length, is normally divided into three parts: (1) the introduction; (2) the body, which consists of the chief steps; and perhaps, (3) the conclusion. Many times, no conclusion is necessary. The writer simply stops after the last step is explained.

The introduction to a process description can contain several items. The introduction must (1) define the process; (2) state its purpose; and (3) list chief steps. None of these need to be long, but each item must be stated or clearly implied. All three items might be handled as briefly as this: "Before two wires can be soldered, the joint must be properly prepared. A poorly-prepared joint may result in a 'cold solder joint' and make little or no contact, even though it may appear to be solid. To prepare a joint for soldering (1) clean the wires to be joined; (2) join the wires; and (3) apply flux."

Questions other than "what is the process," "what is its purpose," and "what are the steps," do sometimes arise and might need to be answered in the introduction of a more detailed description. Other questions follow: "Who performs this process?" "Why is it being described?" "Where is it being done?" "What point of view is used?" If the description is part of a longer item (which it usually is), the technician often needs to explain why the description is included. Point of view might be mentioned if the process description is written for an engineer rather than a craftsman, or intended for a layman rather than a technician. Several authorities believe that the introduction should state the principles involved.

Where should materials and equipment be discussed — in the introduction or in the body? The technician must follow suggestions given in the beginning of the module. If the list is brief, or if the items must be gathered first, then the list should be in the introduction. Otherwise, each item should be discussed as it appears in the body of the process description. This list is often called the apparatus.

The body of a process description is easily organized. Chief steps are listed and explained in the order in which they occur. If the chief steps are complicated, then each may need to be broken into substeps.

How can the communicator determine whether or not to divide steps into substeps? One should use the principles of outlining presented in a previous module. Remember that each step must be a manageable unit.

First, the writer should list all steps that need to be covered. The number of steps should be considered; is the list long? If there are only three to eight steps, no substeps may be necessary. But what if the preliminary list totals fifteen or twenty steps? This number requires grouping. The technician has to identify, from the preliminary list, which steps are chief steps and which are substeps. The technician should remember that each step must be a manageable unit.

Here are suggestions for describing steps in the process. First, and most important, steps must be discussed in the same order as they were listed in the introduction.

Second, the technician should avoid the imperative (command) mood unless the communication is intended to be a set of instructions. In describing how coal is crushed in preparation for burning, the writer should say, "crushing is used to produce the size needed" or "the coal is crushed to a suitable size" rather than "crush the coal to the desired size." The pronoun "you" may be used in giving instructions, but the writer should be sure that it needs to be used and is not an accident or the result of poor thinking or planning.

Third, when describing steps the technician must include everything the audience needs to understand the process. To do this, the technician must be aware of the situation, purpose, and audience. Details should not only show "what" is done, but also "how" and "why."

Assume nothing. For instance, it is important to tell the reader that a boiling water reactor uses steam to drive turbines. It is also important to explain why cooling towers are used and why the reactor is always placed near a large lake or river.

As another example, consider the student who was told to dilute a chemical before using it. The instructor assumed the student would know not to dilute the chemical until the day it was to be used. The instructor's assumption was wrong; the student diluted all 20 gallons the first day and the solution had lost its strength by the time it was to be used. Remember, all details are important.

A formal conclusion may not be needed. Will a conclusion help the reader? If it will not, omit the conclusion. There are several ways of ending the description of a process. They are as follows:

- Summarize the steps by listing them again.
- Relate this process to other processes, other work being done, or other parts of the report or presentation.
- Review special points, cautions, advantages, or disadvantages.

Normally, the technician will need to analyze the communication situation of which the description is a part to determine whether or not a conclusion is needed.

The other type of process description is one in which a person does not play an important part. Examples of this are how a T.V. picks up signals, how solid fuels burn, how clouds are formed, and how liquid cools an engine or a reactor. As with the process in which a person plays a part, this second type of process description is called various titles. "How it happens," and "A mechanism in operation" are examples. In this type of process, either no person is involved or the person involved plays an insignificant role. Therefore, there are some key differences such as when:

- Emphasis is on the process or action – not the operator.
- Equipment and materials become the actors.
- Description is in the active voice.

In an internal combustion engine, emphasis is on the action rather than a person. Even though an operator starts the engine, the description of the tappet, or valve lifter (from another module in this series) makes no mention of a person: "As the cam lobes rotate, they force the valve lifters up, thus changing the rotary motion of the camshaft into a reciprocating motion that opens the valves. As the cam continues to rotate past its raised surface, the valve spring forces the tappet down, thus holding it against the cam surface."

Notice that this section also illustrates two other key differences. The equipment and materials are the actors – the cam lobes, the tappets, and the valve springs carry out the actions with no mention of a person. Also, the description is in active voice instead of passive:

- Active voice – The cam lobes force the valve lifters up. The valve spring forces the tappet down.
- Passive voice – The valve lifters are forced up by the cam lobes. The tappet is forced down by the valve spring.

Organization of this category follows much the same pattern as the process in which a person takes an active part. There is an introduction, a description of the process or operation, and usually some type of conclusion. The conclusion must define the operation and list the steps or sequences of the process. Either the purpose or the basic principle is stated.

Description of the process or operation is again a description of the steps of sequences. The amount of complex detail necessary in the process description depends on the writer's purpose, intended audience, and subject. How much knowledge of the process must the reader have to understand the rest of the report? How much must be explained for the audience to follow the remainder of the oral presentation? How much information does the manager require to interpret the results of the study? The technician has a reason for describing the process in the first place. This reason should dictate the length and complexity of the description, rather than how much the technician knows about the subject.

The conclusion need not be lengthy. A summary or a description of the complete cycle of operation is adequate. Most of the suggestions on the other type of description apply here, too.

The outline of a process description in which a person does play an important role might look like the following:

I. Introduction
    A. Definition of process
    B. Purpose for process
    C. Principle of operation
    D. Main steps or sequences
II. Description of process
    A. First step or sequence
        1. Definition of step or sequence
        2. Detailed description
    B. Other steps or sequences
    C. Other steps or sequences

Now that the basics of the two types of process descriptions have been presented, here are three examples from the course Energy Production Systems. Example A is a process involving a person. In Examples B and C, the operator simply starts the process.

EXAMPLE A: DESCRIPTION OF A PROCESS INVOLVING A PERSON.

Several operations are important in preparing coal for burning. Specifically, they are the following:

- Cleaning
- Crushing
- Sulfur removal

Cleaning methods are employed to remove some noncombustible products from coal. Because many common impurities are more dense than coal, they can be separated by mechanical methods. Particles of different density settle at different rates in a fluid. Heavier impurities sink to the bottom faster in water and, thus, can be separated from coal.

Another method involves placing coal on a screen and blowing either air or water through the bed of coal. Heavier particles fall downward through holes in the screen more easily and can be separated.

A method called froth flotation is applicable to coal of small size. Coal is agitated in a mixture of water and reagents that produce a surface froth. Coal particles float in the froth; whereas, heavier particles sink and can be separated.

Crushing is employed to produce the sizes needed for various types of burners. Sizing standards have been described previously. Crushers have been developed that use toothed rollers, or rotating hammers, or rings that strike the coal and break it up. Crushers are used in conjunction with screens or gratings of appropriate spacing to control the size of crushed coal.

Sulfur is an undesirable element in coal because it leads to air pollution. Sulfur in the form of pyrites (iron sulfide) is removed by the operations of crushing, washing, gravity separation, or froth flotation. Sulfur in the form of organic compounds cannot be removed by these methods. Experimental methods, such as magnetic separation, are being developed for improved removal of pyrites.

EXAMPLE B: PROCESS DESCRIPTION WITHOUT CONSPICUOUS PERSON.

In a boiling water reactor, water heated by removal of heat energy from the core is allowed to boil inside the reactor vessel. The steam is piped to turbines, which are used to drive electric generators. After passing through turbines, steam is condensed, and water is pumped back to the reactor vessel.

A schematic diagram of a boiling water reactor system is shown in Figure 1. The water flows through the core and is heated to about 550°F. The water boils and produces steam at a pressure around 1000 psi. Steam flows through the piping to drive the turbines. (The piping shown in Figure 1 is oversimplified; there are many pumps, valves, etc., in the circulation system.) The steam, of course, carries radioactivity because it has passed through the reactor core.

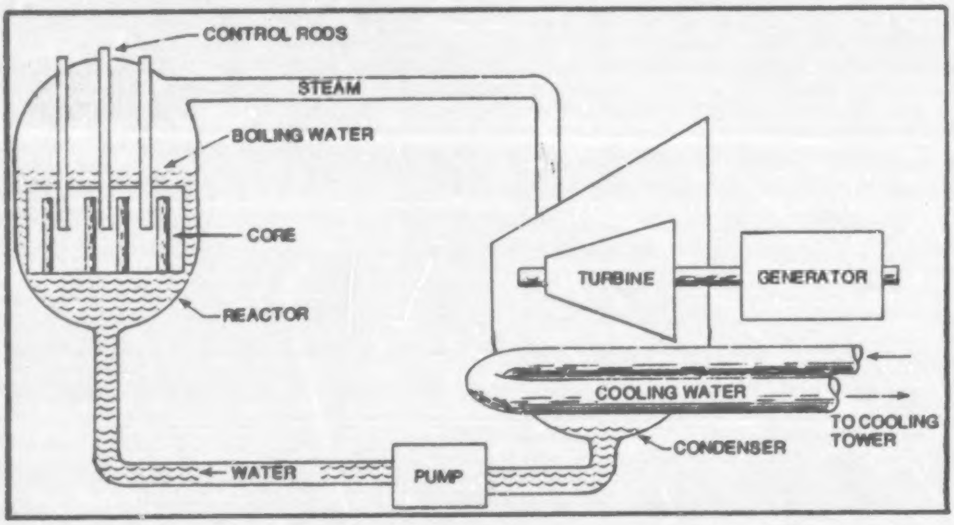


Figure 1. Diagram of a Boiling Water Reactor System.

Water in the condenser is cooled by heat exchange with water from the cooling towers, which are located outside the reactor building. These large cooling towers, which have become familiar as a symbol of nuclear power, allow dissipation of waste heat from the reactor. Most reactors are located near a large body of water — a lake or river — to provide a good supply of coolant. The cooling towers are used to avoid thermal pollution of the body of water.

EXAMPLE C: PROCESS DESCRIPTION WITHOUT CONSPICUOUS PERSON.

There is a competing approach for controlled thermonuclear fusion — inertial confinement fusion. In this approach, a tiny target is compressed and heated in a very short time, less than one billionth of a second. The fusion energy is produced very rapidly, before the fuel has a chance to fly apart. The fuel is said to be "confined" by inertial forces.

A method must be used for heating the fuel very rapidly. One approach is to use lasers, which are capable of producing very high power pulses with extremely short duration. Laser-assisted thermonuclear fusion was first suggested in the early 1960s, and large programs directed at laser fusion are underway in the United States, the Soviet Union, and several other countries.

The discussion of inertial confinement fusion in this section emphasizes the use of lasers for heating fuel. Other heating methods are also under investigation — such as the use of electron beams or ion beams. It should be remembered that there are competing approaches for inertial confinement fusion.

Because the confinement time is short ($\leq 10^{-9}$ seconds), the particle density must be high ($\geq 10^{23}/\text{cm}^3$) in order to satisfy the Lawson criterion. Since the fuel — deuterium-tritium — is gaseous, it must be compressed considerably to achieve the required density (which is higher than the density in solid materials). The approach to heating and confinement is illustrated in Figure 2.

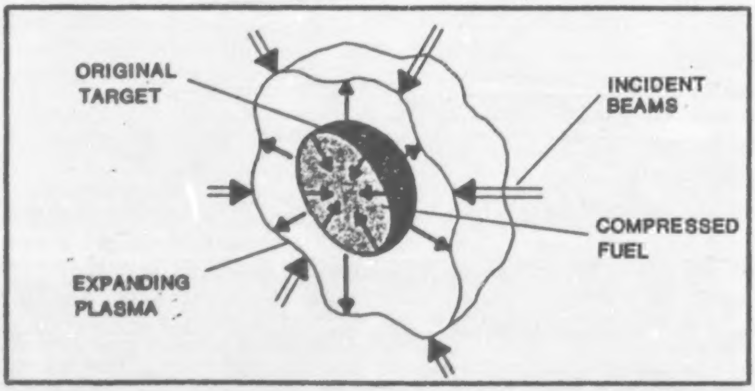


Figure 2. Diagram of Processes in Inertial Confinement Fusion.

Example C. Continued.

The gaseous fuel is contained in a spherical glass shell. The spherical targets being used in current experiments have diameters of approximately 0.01 cm. A number of laser beams (or electron beams or ion beams) strike the target from several different directions, as shown. The beams vaporize the surface of the target and produce a hot, expanding plasma. The expanding plasma reacts on the fuel, compressing it and driving it inward. This process, called an implosion, can produce the required high temperatures and high particles needed to satisfy the Lawson criterion.

The introduction to Example A is brief. Example A lists steps, but the definition is brief and no purpose is given. Discussion of steps is adequate, but not detailed. The description is part of the module "Generation of Steam and Hot Water Using Solid Fuels," and probably does not need to be any more detailed than it is.

Examples B and C are part of the module "Generation of Steam and Hot Water Using Nuclear and Experimental Power Sources." The introduction to Example B does not list the steps or stages as in Example A, but Example B is clear. No other information (definition, purpose, etc.) is needed because this description is an integral part of a discussion about reactor designs. One diagram is included; it is sufficient. This brief description contains excellent details.

Example C is the most complex. It is aimed toward the same reader as the other examples. The introduction in Example C is rather brief; although it mentions the two main steps – heating and confining the fuel – the introduction says very little. Details are adequate. Because of the complexity of the process, only a general understanding is sought. Since they have appeared earlier in the text, the discussion assumes that the reader understands terms like "thermonuclear fusion," "electron beams," "ion beams," "Lawson criterion," and "plasma."

INSTRUCTIONS IN A PROCESS

The description of a process involving a person includes one of the most difficult items a technician is called up to write – a set of instructions. Writing instructions is relatively easy, but composing instructions in such a way that the reader cannot make a mistake is not easy.

What is the secret to writing good instructions? As usual, accurate audience analysis is the key. If the instructions deal with troubleshooting an exhaust analyzer, how much about electronics does the mechanic know? If the instructions explain how to install a thermostat, does the reader know how to identify wires? The technician often assumes that understanding an operation means being able to tell someone else how to do it. Examination of various instructions shows that this is not necessarily true.

Organization is straightforward. The introduction may contain only what the operation is, why it is performed, and what the steps are. Regardless of brevity, the reader should be told what he is doing, why it should be done, and how it will be accomplished. The technician may, as stated earlier, list tools and materials. Perhaps necessary skills will be explained. None of these will replace what, why, and how.

The steps may be, and often are, numbered in the development or explanation section. Steps should be developed in sufficient detail. Sometimes steps may have to be subdivided.

Helpful suggestions should be included; warnings and cautions should be stated.

The conclusion is often simply completion of the last step. A summary or re-listing of the steps should be used whenever possible. Other methods might be mentioned.

Since instructions must be accurate, here are a few suggestions to help avoid problems:

1. Instructions should not be too technical for the intended reader. The target audience should be defined and directions aimed at that level or a little below.
2. Enough detail should be included. The technician must remember that the reader may not know as much about the subject as the technician. Instructions sometimes end up being more a checklist than a workable guide. In a set of instructions for timing an engine, the statement "hook up the timing light" assumes the reader is familiar with correct procedure. If in doubt, the technician should give too much detail rather than not enough.
3. The reader must be instructed to complete the steps in a required manner. The technician should constantly remind the reader of what will happen if certain procedures are not followed. Murphey's Law should be remembered: "If something can go wrong, it will go wrong." If chemicals must be mixed in a certain manner, tell the reader. If the bolts holding the head on a compressor must be tightened with a torque wrench, this should be clear to the reader. If the vapor barrier on an inner wall must be stapled only at certain points, this should be explained. The technician must warn the reader whenever necessary.

4. All necessary information should be explained in early steps. The communicator should not assume that the reader will read the entire set of instructions before beginning. Instructions should request that the reader look over all the instructions before starting, but assume that the reader will plunge right in. Most will. If step seven is influenced by step six, warn the reader early; do not wait until step six to mention the fact.

5. The imperative mood should be used when telling the reader what to do. For instance:
   - Imperative — Connect the wire. Check the pressure. Calculate the hourly usage, and depressurize the system.
   - Declarative — The wire should be connected. Pressure must be checked. Hourly usage can be calculated by the reader, and the reader can depressurize the system.

   Using the imperative is not ordering your reader around; this is the clearest communication. Certainly not all statements must be in the imperative mood. Explanations, warnings, and other such items can be in other forms. A final note about the imperative mood: even though the pronoun "you" is understood, it should normally be omitted. The writer should say "connect the wire" rather than "you connect the wire," even though "you" is the understood subject of the first statement.

6. As discussed earlier in this module, if tools and materials should be assembled, they should be listed in (or directly following) the introduction. Having the

reader get deep into the process only to find that a missing tool is needed can be avoided by listing necessary tools early in the instructions.

7. Long lists of instructions should be broken into several stages or phases. Usually, logical divisions will be apparent. Ten instructions under one phase are easier to understand than forty instructions dealing with the entire process.
8. Diagrams should be used when needed – but only then. Diagrams can be very helpful and should be used when necessary, but they should be used only when they will help the reader.
9. When several unfamiliar terms must be included, a section of definitions should be included. The definitions should be as brief as possible.

Now that some suggestions for writing instructions have been listed, here are two sets of instructions to examine. First, read both sets of examples. Then read the comments. Both examples are laboratory experiments from the course Energy Production Systems.

EXAMPLE D: INSTRUCTIONS WRITTEN FOR LAB EXPERIMENT.

MATERIALS

Spark-ignition engine with at least four cylinders
Set of breaker points that fit the engine
Condenser that fits the engine
Rotor that fits the engine
Feeler gage for breaker points
Timing light
Set of wrenches
Screwdriver set

Example D. Continued.

PROCEDURES

1. Remove the distributor cap.
2. Remove the rotor, condenser, and breaker points from distributor.
3. Replace old parts with new points, a condenser, and a rotor. Do not connect the coil wire to the condenser.
4. Gap the points to prescribed measurement with feeler gages.
5. Connect the coil wire to the condenser.
6. Replace the distributor cap.
7. Insert timing light between the number one cylinder and the corresponding spark plug wire.
8. Time the engine.

EXAMPLE E: INSTRUCTIONS WRITTEN FOR LAB EXPERIMENT (#2).

MATERIALS

Impulse water motor with pressure gage and prony brake
(Sargent-Welch #1101 or equivalent)
Water source
Collection container calibrated in ft^3
Timer

PROCEDURES

1. Set up the experimental apparatus, as shown in Figure 3, with the collection container removed.
2. Turn ON the water supply and adjust the flow for low-speed operation of the water motor. Record the difference in the spring scale readings in Trial 1 of the Data Table (in pounds). Next, record the water pressure in lb/in^2 and convert this value to lb/ft^2.
3. Place the collection container to catch the expelled water and simultaneously start the timer and revolution counter.
4. When a predetermined volume of water has passed through the turbine, read and record the values of the revolution counter and timer; then record the volume of water.

Example E. Continued.

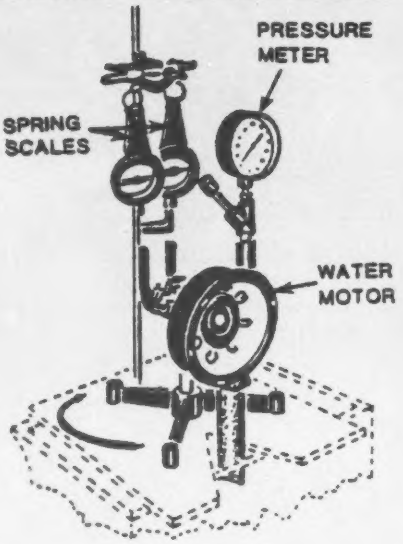


Figure 3. Laboratory Setup.

5. Turn OFF the water supply.
6. Record the circumference of the pulley (in feet).
7. Calculate and record turbine input power from the following equation:

$$\text{Input Power } \frac{(\text{ft}\cdot\text{lb})}{\text{s}} = \frac{\text{Pressure (lb/ft}^2) \times \text{Volume (ft}^3)}{\text{Time (s)}}$$

Equation 1

8. Calculate and record the turbine output power from the following equation:

$$\text{Output Power } \frac{(\text{ft}\cdot\text{lb})}{\text{s}} = \frac{\text{Revolutions}}{\text{Time (s)}} \times \text{Scale difference (lb)}$$
$$= \text{Pulley circumference (ft)}$$

Equation 2

9. Calculate and record turbine efficiency.
10. Repeat the steps for two higher water-flow rates and complete Trials 2 and 3 of the Data Table.

Example E. Continued.

DATA TABLE 1

Trial	Scale Difference	Water Pressure		Number of Revolutions	Time	Volume of Water	Input Power	Output Power	Efficiency
#	oz lb	lb/in²	lb/ft²	#	s	ft³	ft·lb/s	ft·lb/s	%
1									
2									
3									
Pulley circumference = ____ in = ____ ft									

As stated earlier, both Examples D and E are laboratory experiments, which somewhat affects the structure. For instance, neither example has an introduction, which probably would have helped. Materials were listed so that the student could assemble them before beginning the experiment.

Both experiments assume quite a bit. In Example D, procedures 1 and 2 assume that the student knows how to remove the items. Some distributor caps require depressing and turning rather hard-to-see screws. Some rotors are simply pulled off; others are held on by screws. Procedure 8 assumes the most, since timing the engine is rather critical and requires some cautions. Obviously, if Example A were written for someone other than a student who had just read a thorough discussion, more details would have been needed.

Some of the same comments on Example D apply to Example E, but the second set of lab instructions contains more details. It, too, assumes that the student understands certain terms and procedures, but more explanation is included.

This module has presented rules and conventions for writing the description of a process, explaining how something works, and giving directions. These techniques are an integral part of the technical communicator's routine duties. These writing skills must, therefore, be practiced until they become simple for the writer.

EXERCISES

1. Using some process in your field of study, write two descriptions of about 200 words each. Write the first one for an uninformed reader and the second for a person in the field. Identify the intended reader.
2. Select a process related to your technology and write a set of instructions for another technician. Pick a process complex enough to require a description of at least 200 words.
3. From a magazine or a textbook, bring to class an example of a process description involving a person, one in which a person is not conspicuously involved, and a set of instructions. Be prepared to evaluate each one using the criteria discussed in this module.

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1. Define a process.

2. List two types of processes.

3. List three problems that can arise in describing a process.

4. List what must be adapted to the intended audience during the description of a process.

5. Where can the list of materials and equipment be placed in a process description? Where do the lists appear most often?

6. How are chief steps organized or arranged?

7. List three items that are normally in the introduction. List three items that are sometimes in the introduction.

8. What determines whether chief steps should be divided into substeps?

9. What is the imperative mood? When should it be used?

10. What determines how much detail to use when discussing steps?

11. What determines if a conclusion is needed?

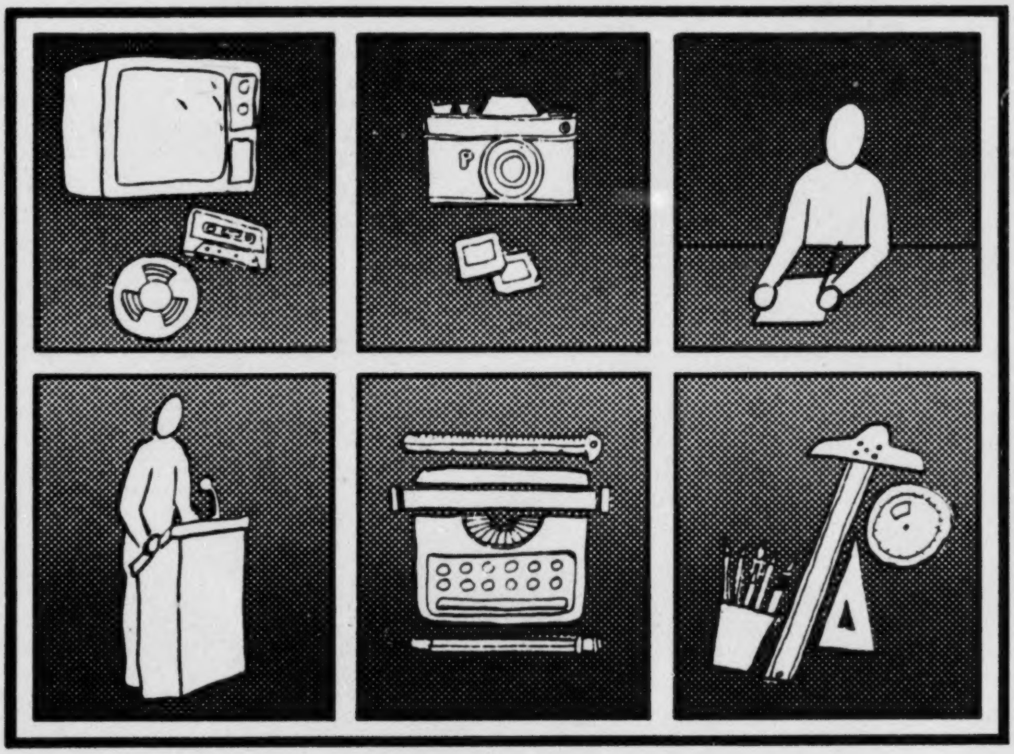
12. List three key differences between a process where a person is not conspicuously involved and one in which a person is involved.

13. List seven suggestions for writing instructions.

ENERGY TECHNOLOGY

CONSERVATION AND USE

TECHNICAL COMMUNICATIONS



MODULE TC-07

PERFORMING ORAL AND VISUAL PRESENTATIONS

CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

INTRODUCTION

Previous modules have alluded to the oral and visual aspects of technical communications, but no concentrated set of suggestions for these two vital areas has been given. This module condenses some keys to effective oral communications and visual illustrations.

PREREQUISITES

The student should have completed the first module of Technical Communications.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. List some situations in which a technician will use oral skills.
2. List six steps in constructing an oral presentation.
3. List questions one must ask when selecting a subject for an oral presentation.
4. List several aspects of audience analysis.
5. Compare three ways to deliver an oral presentation; explain which method is best.
6. List suggestions for constructing the introduction, body, and conclusion of a presentation.
7. List four suggestions for using visual aids in an oral presentation.
8. List four ways group communications can be classified.

9. List essentials for being a participant in, and for being a leader of, group communication.
10. List steps in preparing to lead group discussion.
11. List suggestions for handling the opening, mutual exchange period, and termination of a person-to-person transaction.
12. List suggestions for handling preparation and planning of an interview, and for conducting the interview.
13. List three reasons to use illustrations.
14. Compare formal and informal tables.
15. Define a bar graph, circle graph, line graph, flow chart, organizational chart, and line drawing. Give two suggestions for constructing each.
16. Prepare and deliver an acceptable oral presentation.
17. Prepare an acceptable informational interview.
18. Lead a group discussion.
19. Construct the visual illustrations discussed in this module.

ORAL AND VISUAL ASPECTS OF TECHNICAL COMMUNICATION

So far, this course has emphasized the written assignments a technician may encounter such as reports, research, definitions, and instructions. Each of these can be, and often is, accompanied by an oral presentation. Because a technician must often present ideas both orally and visually, this module condenses key suggestions on the oral and visual aspects of technical communication.

In this discussion, oral presentation means any of the oral communication duties a technician encounters: oral reports, group discussions, conferences, interviews, and person-to-person transactions. This module relates the basics of preparing and carrying out these activities.

The visual items a technician prepares (or directs others in preparing) usually fall into these categories: tables, charts, graphs, diagrams, and photographs. Knowing how to select and prepare these aids is important, since the technician must often be the expert in these areas, regardless of prior training.

ORAL PRESENTATIONS AND ACTIVITIES

Oral communication is a part of everyone's job; it cannot be excluded. However, the technician may need oral skills more than might be imagined. The technician may have to: (1) Demonstrate a new technique to fellow employees; (2) explain an energy audit to top personnel; (3) answer questions before a group of potential customers; (4) chair a decision-making discussion; (5) interview an expert to get answers to a problem, or other similar activities. The technician's ability to analyze the subject, situation, and audience and to speak appropriately affects project success. If the assignment is to demonstrate, the speaker must explain clearly and vividly. If the objective is to sell a product, the speaker must be able to see the product from the potential buyer's viewpoint and to approach the oral situation accordingly. If the objective is to lead a group discussion or to conduct an interview, both situations may have long-lasting effects on the technician's career — as well as the company's success.

The remainder of this section will examine several oral communication situations and make suggestions for each. These situations are: (1) oral reports and presentations; (2) group discussions and conferences; (3) interviews; and (4) informal, one-on-one discussions.

ORAL REPORTS AND PRESENTATIONS

When oral communication is mentioned, the first thought that usually comes to mind is making a speech. Other activities are important, both to the individual and to the company; but beginning this discussion with reports and presentations is logical, since oral presentations are often required. Most of the suggestions about oral presentations apply to other oral activities as well.

The well-prepared speaker usually follows a logical pattern in constructing a presentation. Although authorities have a little trouble agreeing on the order of the following steps, most list these as important:

1. Select a subject.
2. Determine the purpose.
3. Analyze the audience and the occasion.
4. Gather and select material.
5. Prepare an outline.
6. Practice aloud.

Selecting the subject may be the easiest step, if the subject is assigned, rather than chosen by the speaker. Even if the general topic is set, the speaker usually has some control over how the topic will be approached. For example, if Jill Samuels were asked to suggest some energy saving tips to a local PTA, she might ask herself these questions:

A. Which aspects are interesting to me?
B. Which aspects will be interesting to the audience?
C. What is the audience comprehension level of the energy field?
D. How much can be covered in the time allotted?

Jill's questions could be asked anytime a suitable subject is being sought.

To determine the purpose, the speaker generally aims to inform, persuade, or entertain the audience. The purpose of most technical presentations is to inform and/or persuade; therefore, the humorous or entertaining presentation will not be discussed, since it is so seldom needed.

After the speaker decides that the general purpose of the presentation will be to inform, then a specific objective must be determined. If the general purpose of a presentation is to help the audience understand the concept of Ohm's law, the specific objective can be to teach listening participants to work simple problems. Or the specific objective can be to equip listeners to pass a performance exam involving calculating the correct resistance necessary to drop 100 volts in a specific sophisticated circuit. The more complicated the specific objective, the more the speaker must analyze the audience.

Analyzing the audience is always necessary, even in informal situations. The speaker or leader should know as much about the audience as possible; the language, visuals, technical level, and many other aspects must be adapted to listeners. The following factors should be considered when analyzing an audience:

A. Composition — This includes age level, size, sex, vocational interests, educational level, professional memberships, cultural and ethnic background.

B. Beliefs and attitudes — These include the audience's attitude toward the speaker, the audience's attitude toward the subject, and the audience's attitude toward the purpose of the speech.

Analyzing the occasion means answering some questions. What is the purpose of the occasion? Who will precede and follow the presentation? What physical conditions will exist? Is 20 minutes set aside? Is the preceding speaker known for not following schedules? Are slides a part of the presentation? Can the room be darkened?

Gathering and selecting material is the next step in preparing a presentation. In many cases, the technician has much more material available than can be included in the presentation. The job then becomes how to limit or select from the available information. If more details are needed, they must be sought from helpful sources. These sources are: interviews, journals, libraries, and other areas (in Module TC-02 "Conducting and Reporting Research").

Preparing an outline culminates the analysis of subject, purpose, situation, audience, and self. Sometimes, a presentation may be memorized. Sometimes, the presentation may be read. Hopefully, these occasions will be few. The most interesting presentation to hear is one that is delivered extemporaneously — which means that the presentation was carefully planned, but is not memorized or read.

An extemporaneous presentation will never be delivered the same way twice. The speaker uses a well-planned outline, but does not write the entire speech. This method does have some disadvantages, which are the following:

1. The speaker may leave out something. This is not as significant as it sounds, because the audience probably will not notice.
2. It is difficult to keep track of time. If the presentation can only be 15 minutes long, then the speaker must limit his speech to the time allotted.

Disadvantages are offset by advantages in most cases. Advantages are the following:

1. An extemporaneous report is more flexible. If the audience wants more, material can be expanded. If the audience is bored, a report can be shortened.
2. A speaker can maintain better eye contact with the audience, which keeps listeners more interested.
3. The extemporaneous presentation usually sounds more enthusiastic.

The point is that, unless there is a special reason for memorizing or reading a presentation, the oral exercise can be delivered extemporaneously from an outline.

How should an outline be constructed? Like any other piece of communication, the outline has a beginning (introduction), a middle (body), and an end (conclusion).

Some suggestions for the introduction, body, and conclusion are in order.

The introduction has three objectives: (1) to catch the audience's attention; (2) to state the purpose of the presentation; and (3) to list the main points in the organization of the presentation.

The speaker can catch the audience's attention in one of several ways, such as: (1) asking a question and then providing an answer; (2) making a startling statement; (3) telling an illustrative story; (4) making a reference to the speaking situation; (5) making a reference to the subject; (6) stating a quotation; or (7) relating a humorous anecdote.

Following the attention-getter, purpose is stated either directly ("The purpose of my presentation is ...") or indirectly ("There are several ways to approach this problem."). Then, main points are listed: "Three ways of attacking the problem are hiring a consultant, running the tests suggested in the manual, or eliminating that section of the procedure." This list becomes the audience's roadmap of what is to follow in the body of the presentation.

A typical introduction might sound something like the following:

The company's main problem at this time is saving energy.	(Reference to the subject)
That is why we are all gathered here today.	(Reference to the occasion)
Did you know that three simple changes could save the company 37% of the current expenditures?	(Question and startling information)
Today I want to look at these three changes in detail.	(Statement of purpose)
The key changes are to condense more operations into fewer areas, to buy only vehicles that will average 23 miles per gallon, and to reduce operating hours.	(List of main points)

The body of the presentation is the bulk of the material that the technician wishes to offer. The body should be prepared first; the introduction is prepared second. The conclusion is prepared last. Since the body is an outline, the student should follow the suggestions from Module TC-03, "Writing Outlines and Abstracts" — especially the ideas on brainstorming and arranging the order of points.

The speaker should not usually try to discuss more than five points in a presentation. This does not mean that more than five steps cannot be presented. However, if several items must be mentioned, they should be grouped under five or less major headings in the body. The outlining module explains how to select and arrange ideas.

Main ideas can be developed both verbally and visually. The latter portion of this module will suggest visual supporting methods. Points can be developed verbally using methods such as the following: (1) explanation; (2) restatement; (3) hypothetical and factual illustrations; (4) statistics; and (5) quotations. The easiest methods are explanation and restatement, because the speaker is usually well versed in the subject and can accomplish this without much preparation. Spending extra time to gather statistics and the opinions of others can add support and create interest in the topic.

The conclusion need not be elaborate, but it should be definite. When the speaker indicates "this is the end," it should be. A rambling, drawn-out conclusion is distracting and takes away the good effects of the body. The presentation could end with: (1) a summary listing the points again; (2) a quotation; (3) a story; (4) the speaker's personal intentions; and/or (5) a further inducement by the speaker. If the presentation's objective is to inform, the conclusion should include a summary, in addition to any other techniques employed.

Constructing the outline is not difficult, but does require time and thought. The fact that the speaker is well-acquainted with the subject may not be advantageous. One must decide what aspects to cover and must assess the audience's ability to understand the topic. One must make the information interesting. One may have to explain an operation in several ways. Each of these tasks may require extra time.

Practicing aloud is the last step in preparing for the presentation. In this part of preparation, the speaker works on developing eye contact by looking at an imaginary audience. The speaker should stand relaxed, but equally on both feet, and should not lean on the speaker's stand. Although the presentation should be timed, length can be expected to vary, since the format is extemporaneous.

Some authorities suggest practicing in front of a mirror; other suggest picking a friend to be the audience. Still others think practicing aloud – alone – is the best preparation. One should adjust the method to personal taste. Also, during practice, corrections, deletions, and additions can be made to the presentation. Each practice session will net new ideas.

Delivering the presentation will be easy if all preparatory steps are followed. Preparation also give the speaker a feeling of confidence – which helps eliminate stage fright.

Visual aid should be used whenever possible. The speaker should remember four simple suggestions: (1) Make visuals simple; (2) make them large enough to be seen; (3) do not stand in front of the visual; and (4) make sure the visual is directly related to the subject.

LEADING CONFERENCES AND GROUP DISCUSSIONS

Any person may be called upon to lead or participate in a group discussion of some type. Therefore, although leading a group may seem unrelated to electronics, solar energy, or other technical areas, it is likely that the technician will be involved in such activities.

Group communication can be classified two ways. If classified by purpose, group discussions are either learning or decision-making discussions. If classified by form and format, group communications are usually called conferences or meetings. This module will approach group communication from the standpoint of purpose, but the two basic formats will be addressed briefly.

Conferences are usually business briefings and are called to solve problems. Meetings are more formal, and may include speeches and entertainment. A meeting usually follows an agenda, which may include these items:

1. Secretary's minutes of the last meeting
2. Treasurer's report
3. Committee reports
4. Old business
5. New business
6. Program

Meeting participants follow the rules of parliamentary procedure in handling main motions, subsidiary motions, and others. The student should peruse a copy of Robert's Rules of Order or any other good source on parliamentary procedure.

As stated previously, the purpose of group communication can be either to learn new information or to make decisions. In a learning discussion, participants exchange information to increase their understanding of a subject. Structure of a group discussion may not be very rigid. Group discussions occur when clubs, company departments, civic groups, and others meet to exchange ideas or to seek facts.

In a decision-making discussion, the purpose is to agree on a future policy or course of action. For example, the supervisors of a company may try to agree on a new safety policy; the club's executive committee may suggest modifications to the constitution; or the executives of a business may meet to decide on a new course of action.

There are several essentials for group communication. A participant should: (1) have as much knowledge of the subject as possible; (2) be acquainted with the other members of the group; (3) pay close attention to the discussion; and (4) make meaningful contributions to the discussion. Essentials for the leader are: (1) to effectively express results through summarizing; (2) to maintain impartiality; and (3) to sustain an encouraging or permissive attitude toward participants.

The steps in leading a group discussion of any type are: (1) investigating subject group; (2) preparing a plan; and (3) leading discussion. A preliminary investigation requires that the leader learn as much about the subject and the group as possible. The leader may have to gather extra information, interview others from a tentative viewpoint, and decide what effect this viewpoint will have on others in the group.

To investigate the group, the leader needs to know the participants' background, their knowledge of the subject, and how each may react to the ideas or proposals to be presented. This information may be gathered in a number of ways: (1) talking with key members; (2) asking those unaffected by the group's actions; and (3) attending other meetings that involve some or all of the members.

Steps in preparing a plan depend on the situation, as well as the results of the preliminary investigation. An agenda must be prepared and, perhaps, distributed to the participants. If the situation is a conference, the agenda may look like a list of questions to be answered. If the situation is a meeting, the agenda will have a formal format. The style of the format will have been set by previous customs or practices. The plan may be simple, such as when a conference is called to apprise progress of a modification project. The plan may be more complex if the conference's purpose is to solve a safety or budgetary problem. If the purpose of the conference is to make a complex decision, the discussion plan might be as follows:

1. Definition of the problem
2. Analysis of the problem
   a. Evidence of problem
   b. Persons affected
   c. Causes of problem
   d. Aspects that must receive immediate attention
   e. Criteria by which solutions must be judged
3. Suggested solutions
4. Evaluation of proposed solutions
5. Methods of putting solutions into operation

After conducting a preliminary investigation and making a plan, the last step is leading the discussion.

The leader can start discussion by stating the problem or question and explaining how it relates to the participants. Another method of beginning discussion is to call on individuals and ask them to give their opinions. A third way to begin is to state some extreme points of view on the question and ask for reactions.

How can the leader keep the group from straying from the main issue? The best techniques are to write an outline on the board or to pass out an agenda and stick with it. Such items provide a visual progress chart, but the leader can let the discussion digress if this seems logical. The leader should also summarize throughout, and at the conclusion of, the discussion.

How can the leader ensure equal participation? The leader might avoid recognizing a talkative participant by looking the other way. Inviting less talkative members to speak is another equalizing technique, although this is not always successful. The leader might even tactfully say that the conference would be more profitable if everyone had a chance to talk. Certainly, a knowledge of parliamentary procedure is necessary.

How does the leader resolve conflict? It is essential that the leader remain neutral, walk the middle line, and be able to differentiate between honest conflict and irrational disagreements. If the conflict involves interpreting facts, retracing the reasoning may help. When the conflict becomes overheated or irrational, the leader may allow only facts and rational reasoning to be introduced. In extreme cases, the leader may adjourn the meeting until a later time.

Leading group discussion is not that difficult if the leader will investigate the question and the group, and plan the approach in order to lead in an effective manner. A good leader is neutral, summarizes often, is organized, and is not threatened by conflict.

INTERVIEWS AND OTHER PERSON-TO-PERSON TRANSACTIONS

Person-to-person communication makes up most of anyone's verbal transactions; the technician is no exception. Since more planning usually goes into formal assignments (delivering oral presentations and leading group discussions) a greater portion of this module has been devoted to these topics. However, this does not lessen the importance of person-to-person communications; transaction of information from individual to individual is a crucial part of the technician's routine. The technician must interview others to gather information. Sometimes an interview is planned; sometimes an interview is unplanned. A casual conversation may be the time for sensing a worker's attitude toward a company project or policy, or a customer's reaction to a job performed by the technician's company. The interpersonal oral transaction is the fabric of the technician's day-to-day communication.

Most person-to-person transactions fall into three identifiable stages. These stages are: an opening period; a mutual exchange period; and a termination period. The opening period is a time for establishing rapport. The technician may try to get to know the other person by finding a common interest and showing genuine interest in what the interviewee has to say. Making the other person comfortable is much easier if the technician is relaxed, open-minded, and sincere. Dealing with the subject at hand and asking questions that require more than a "yes" or "no" answer can also help establish rapport at the beginning of a conversation.

During the mutual exchange period, the technician attempts to maintain interaction. Being an active listener is one of the most important requirements during this period. An active listener must adapt to the conversation, not dominate the discussion, and not be defensive when sensitive subjects arise. Respecting and trusting the other person are essentials.

An encounter should be terminated with the appropriate "thank you" and any other conventions that the other person might expect. The technician may want to summarize the main points of the conversation. Listing the points of agreement and the unresolved differences will help assure that both persons agree on them.

During an interview there should be an investigation stage, a planning stage, and the interview itself.

During the investigation stage the informant is selected. Then the interviewer asks the informant's permission for the interview, sets a time, and explains the interview's purpose. In the interim, the interviewer tries to learn as much about the interviewer as possible.

The planning stage is the time to clarify the purpose, select the format, and identify specific questions to ask. What information is actually needed? How structured will the interview be? What questions can or should be asked to discover the important information?

In conducting the interview, the interviewer should be on time, move at a lively pace, and end as quickly as possible. The interviewer should do adequate homework on the subject before the interview and should take accurate notes during the interview. The interviewer should be neutral and not reveal points of disagreement, unless the purpose of the interview is to resolve these matters. The usual purpose of an interview is to gain information; therefore, doubts or disagreements should be avoided.

The interviewer should end by thanking the interviewee. Then, the interviewer should make final reports and summaries while the information is still fresh.

VISUAL ILLUSTRATIONS

Even the unskilled communicator can prepare illustrations to assist oral and written presentations. Illustrations make presentations more clear, more concise, and more emphatic.

Knowing when and how to use tables, graphs, charts, drawings, and photographs can assist a technician in all phases of the communicative job. This section will attempt to show what illustrations can do, what kind of illustrations to use, and how to adapt them to different situations.

WHAT ILLUSTRATIONS CAN DO

A picture may be "worth a thousand words," but the wrong picture may take a thousand words to explain. An illustration is a tool meant to help the writer or speaker communicate; therefore, the tool must be selected carefully and used wisely.

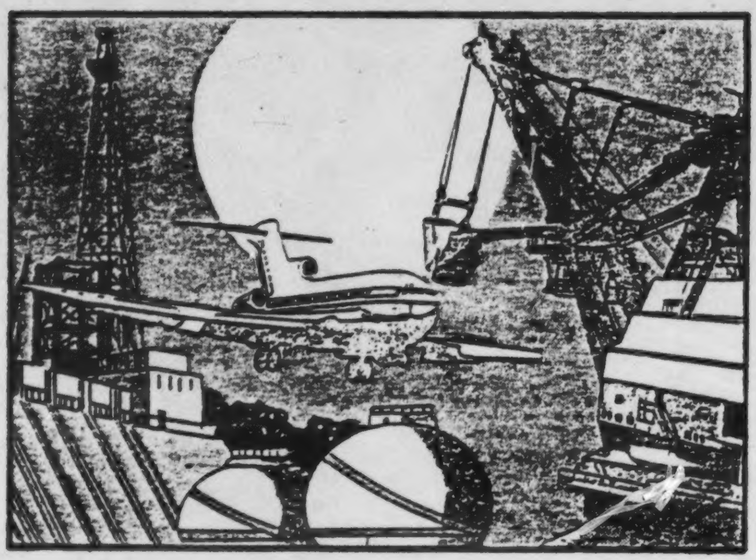
An illustration may be included to add interest, to give emphasis, to condense the presentation, or to promote clarity. A drawing or picture added for interest should fit the subject matter and not detract. This kind of illustration should be in the semi-technical or nontechnical material section.

If an illustration is added to give emphasis, it should be carefully selected, since the reader or audience will remember it longer than other items. The cover illustration shown in Example A shows such use. The reader's attention will be drawn to the pictured aspects, so they should be the most important ones.

Illustrations may be added to make the presentation more concise. If this is the purpose, the technician should experiment a bit. Bar or circle graphs may not always be concise, but tables, drawings, and photographs usually are.

Illustrations can increase clarity, for tables can show mathematical relationships and drawings can show shapes better

EXAMPLE A. COVER ILLUSTRATION USED FOR EMPHASIS.



than words. Even simple, rather rough, illustrations can enhance a presentation by showing items – rather than just describing them.

TYPES OF ILLUSTRATIONS

Authorities index illustrations in various ways. However, most sources agree that illustrations fall into two general categories: tables and figures. A table is two or more parallel columns of data. A figure can be a graph, a chart, a drawing, or a photograph. Each has advantages and disadvantages, and most information can be illustrated in several ways. The technician must analyze purpose and audience and then select the best illustration. A good rule of thumb is: Use tables when brevity is important, when a large amount of information must be presented, or when precision is more important than emphasis or interest.

Tables

Tables are classified as formal and informal. An informal table is fitted into the text much like a paragraph. It probably has no borders, is not listed in the list of illustrations, and is not numbered. The informal table may be as simple as the one in Example B.

EXAMPLE B. INFORMAL TABLE.

In 1978 we had three energy audits —

1.	April 23	Plant B	Replaced boiler 4
2.	June 30	Plant C	Added three-phase motors to bay 4
3.	September 20	Plant A	No changes

Most tables in written reports are formal. Tables in written reports are usually: (1) bordered; (2) given a specific number and title, such as "Figure 5, BTU Ratings of Units"; (3) indexed; and (4) placed on separate pages. The following are suggestions for constructing formal tables:

1. Every formal table should have a number and a title. The title, or caption, should be brief and descriptive. Tables are usually numbered consecutively, but may be coded to chapters.
2. Each column should have a heading that indicates the contents of the column. Quantities should be expressed in similar units. All measurements of current should be stated in either amps or in milliamps, diameters can be expressed in inches or centimeters, but not mixed within the same list. However both expressions (such as both inches and centimeters) may be used together if consistency is maintained throughout the list.
3. Standard symbols and abbreviations should be used, but they should be suited to the audience's comprehension level.
4. The table may or may not be explained in the text, but should always be mentioned.
5. The table should be horizontal, unless it is too long to fit on the page.
6. Spacing will usually separate columns adequately. Use grid lines sparingly.
7. A table should be placed in the main text if the reader needs to know the information in order to understand the material. If the information is simply nice to know, the table should be in the appendix. If there is some doubt about the data's applicability, the table should go in the main text. The following three tables (Example C) are examples of formal tables.

EXAMPLE C. FORMAL TABLES

TABLE 1. TROUBLESHOOTING OF FANS AND BLOWERS.

TROUBLE	CAUSE	CORRECTIONS
Low Output	(a) Dampers closed (b) Loose belts (c) Dirty filters (d) Blower hose plugged (d) Variable pitch or speed control malfunction	(a) Open dampers; clean and adjust damper assembly (b) Tighten belts (c) Clean or replace (d) Clean out hose (e) Inspect and repair system as required
Bearing Failure	(a) Bearing not lubricated (b) High-temperature lubricant not used in hot conditions (c) Pillow block on shaft misaligned (d) Belts too tight (e) Dust enters bearing from around shaft	(a) Lubricate properly (b) Use hig-temp. lubricant and heat flingers (c) Align (d) Loosen belts (e) Use shaft seal

TABLE 2. ESTIMATED NATIONWIDE EMISSIONS, 1968.
(in millions of tons per year)

Source	Carbon monoxide	Particulates	Sulphur oxides	Hydrocarbons	Nitrogen oxides	Total
Transportation	63.3	1.2	0.3	16.6	8.1	90.5
Fuel combustion in stationary sources	1.9	3.9	21.1	0.7	10.0	45.9
Industrial processes	9.7	7.5	7.3	4.6	0.2	29.3
Solid waste disposal	7.3	1.1	0.1	1.6	0.6	11.2
Forest fires, agricultural burning, coal waste fires	16.9	9.6	0.6	3.5	1.7	37.3
Total	100.1	28.3	33.2	32.0	20.6	214.2

Example C. Continued.

TABLE 3. A SUMMARY OF THE ERDA PLAN GOALS.

	United States energy conversion goals (10^{15} BTU)	
Energy Source	1985	2000
Coal gasification and liquefaction	0	0
Direct coal utilization	6	9
Oil shale	2.0	4
Enhanced oil and gas recovery	6	9

Figures

The second category of illustrations — figures — includes all illustrations that are not tables, such as graphs of all types, charts, drawings, and photographs. Obviously, figures are extremely varied.

Selecting the appropriate figure depends on the situation, the information to be communicated, and the intended audience. If the figure's purpose is to compare sizes graphically, perhaps a bar graph is the best illustration. To show how a whole is divided into its parts, a circle graph might be selected. A line graph is a good figure to show fluctuations (such as temperature or voltage) over a period of time. A flow chart is a clear way of showing a process, such as how a television works. A line drawing is ideal for showing how something looks. Each figure type can be constructed by an amateur with minimal equipment.

A bar graph is one of the easiest figures to construct. Bars usually are drawn vertically because differences in height are more striking; however, there may be reasons for using horizontal bars. Bars should be no higher than a half-page, making maximum bar length about five inches. Bars are arranged from longest to shortest or from shortest to longest.

To show even more information, the bars can be segmented. For instance, notice that in the following horizontal bar graph (Example D), the use of different fuels is shown by segmenting bars as to various users.

EXAMPLE D: HORIZONTAL BAR GRAPH WITH SEGMENTED BARS.

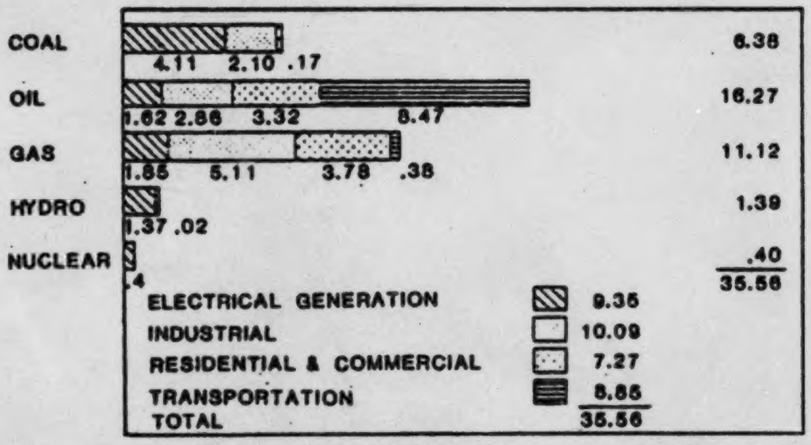


Figure 1. Pattern of U.S. Primary Fuel Use (1973) — (oil equivalents-millions of barrels per day.)

Horizontal graphs can contain line drawings, as in Example E:

EXAMPLE E: HORIZONTAL BAR GRAPH WITH LINE DRAWINGS.

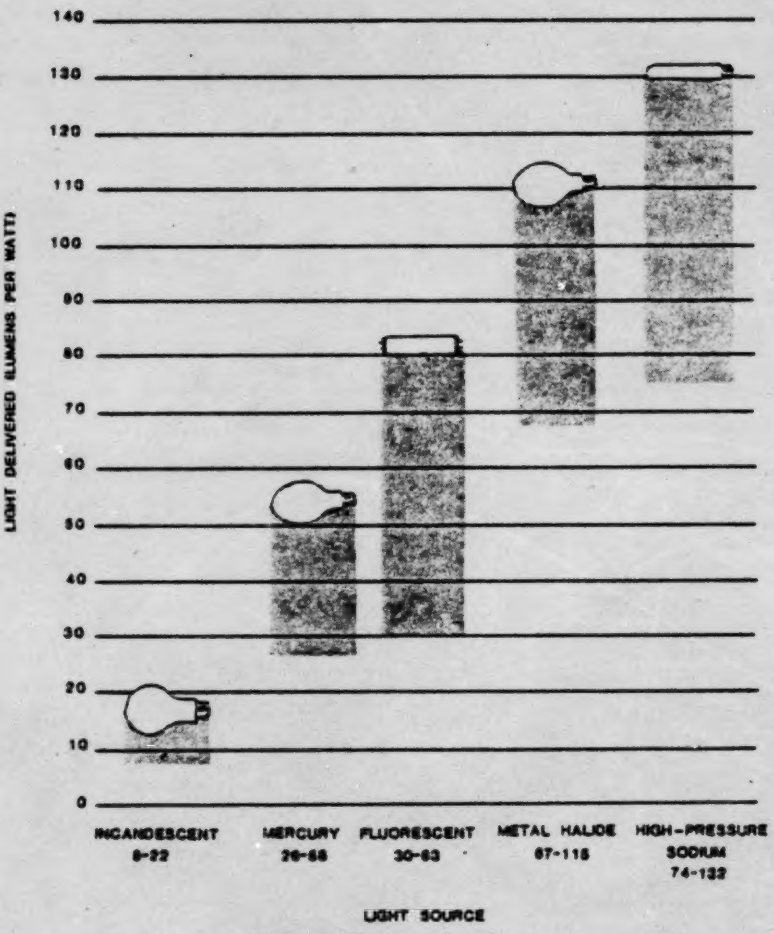


Figure 2. Efficiency of Various Light Sources.

The circle graph, also called a pie chart, is a convenient way of showing a whole divided into parts. A protractor, a pencil, a compass, and a ruler, are the only tools needed to construct a circle graph. Slices need to be fairly large, and there should be at least three slices — but no more than seven. Small slices can be grouped together under "other," since more than two slices of less than two percent will weaken the circle graph's impact. All lettering should be done horizontally, so that it can be read as part of the page. Notice that in Example F, words too large to fit within a slice are either extended out of the chart or placed entirely out of the circle with lines connecting words to the appropriate space. Percentages should usually be stated, although there are exceptions.

EXAMPLE F: PIE CHARTS.

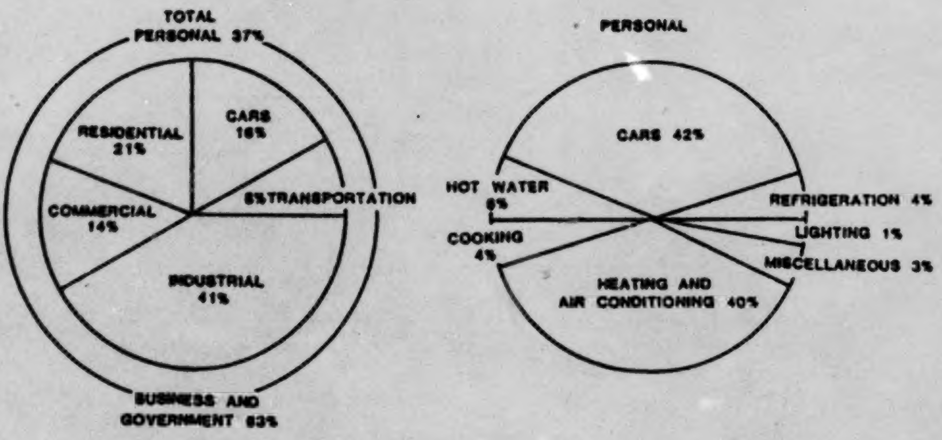


Figure 3. Today's Energy Use.

Example F. Continued.

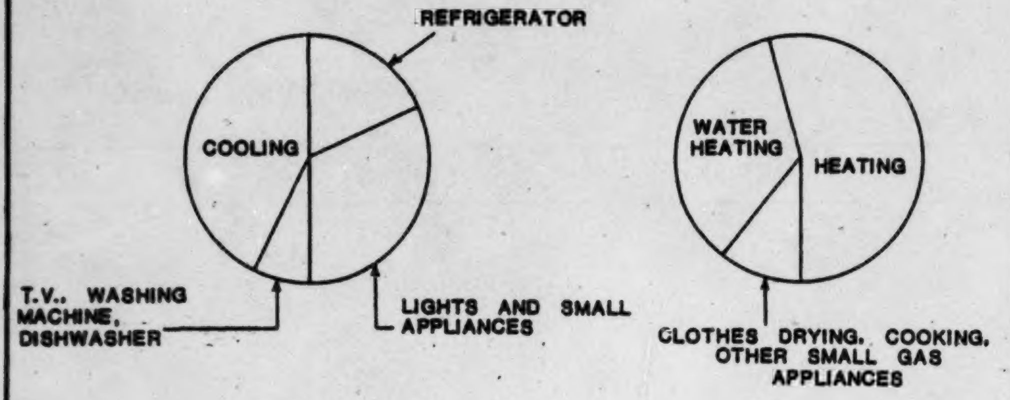


Figure 4. Average Gas and Electric Uses — Gas/Electric Home.

Line graphs are more variable in form than bar or circle graphs. They also vary in complexity, depending on the writer's knowledge and the knowledge level of the intended audience. However, line graphs have some things in common with bar and circle graphs.

A line graph usually charts two variables: the controlled variable, which is predictable; and the uncontrolled variable, which is unpredictable. The line chart is constructed to show how the uncontrolled variable fluctuates with changes in the controlled variable. Usually, the controlled variable is plotted horizontally and the uncontrolled variable is plotted vertically, with the common point (which does not have to be zero) in the lower left-hand corner. Fluctuations appear vertically, as shown in Example G.

The controlled variable is often time, as shown in Example G, Figure 6.

EXAMPLE G: LINE GRAPHS.

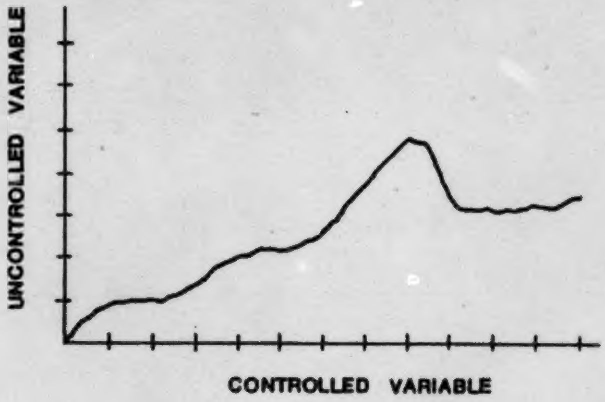


Figure 5. Line Graph Format.

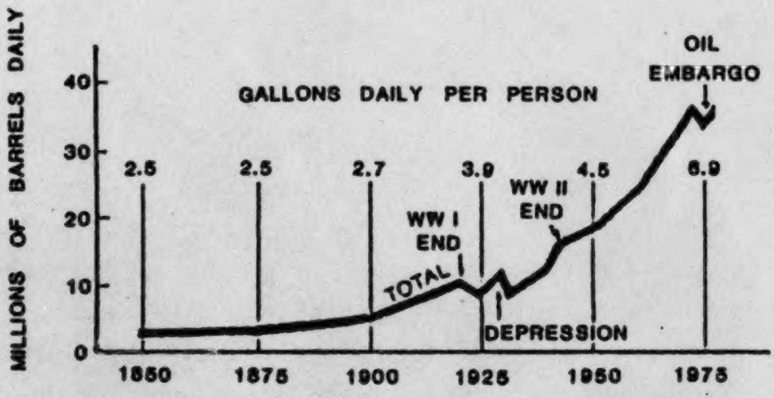


Figure 6. Historical U.S. Energy Consumption in Oil Equivalent Units.

Several lines may be plotted on the same graph for easy comparison; one line can be a broken (or dash) line and the other solid. Too many lines can be confusing; three lines is usually the limit. A key must be included on the line graph to identify variables.

In Example H, the key is part of the graph. The graph shows two controlled variables, one on the left and one on the right.

EXAMPLE H: LINE GRAPH, WITH KEY (SHOWING TWO CONTROLLED VARIABLES).

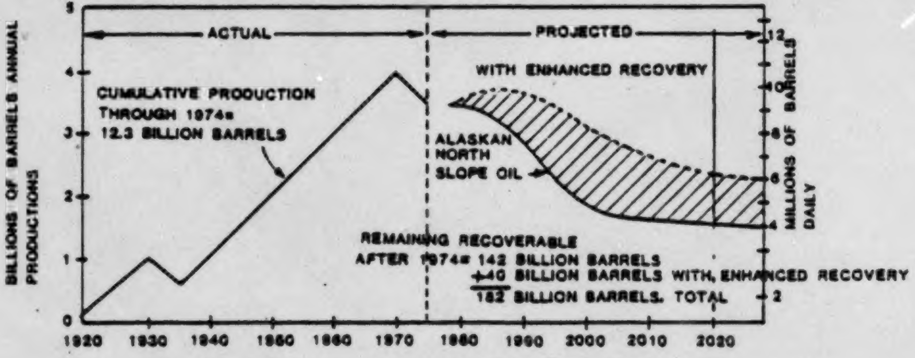


Figure 7. U.S. Crude Oil Production.

Flow charts and organizational charts are similar. Rectangles are connected to show either how a process moves from one stage to the next, or to show the organizational structure of a large organization. Flow charts usually begin at the upper left of the page. An organizational chart normally has the chief officer of the organization at the top of the chart with other officers delineated below. The flow chart is connected by arrows, to show movement; whereas, the organizational chart is connected by lines, as the organizational chart represents a static situation. In Example I, the flow chart shows the areas a person must master to become an energy technician.

EXAMPLE I: FLOW CHART.

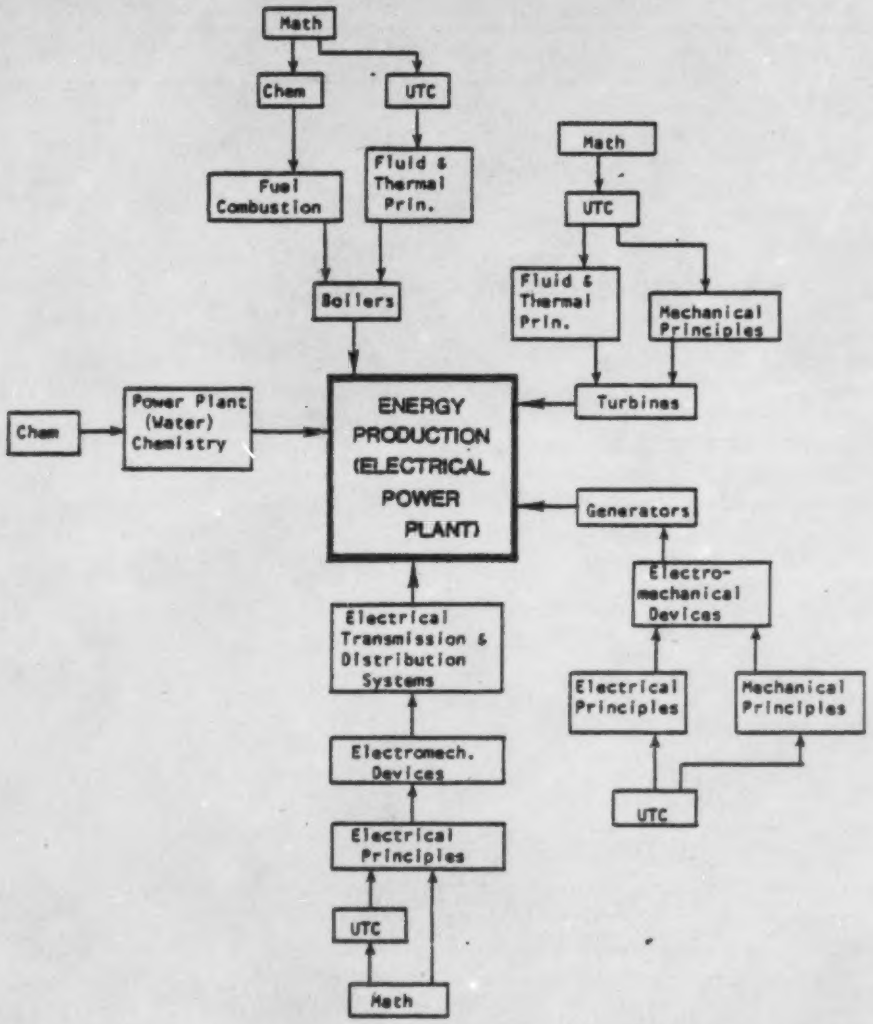
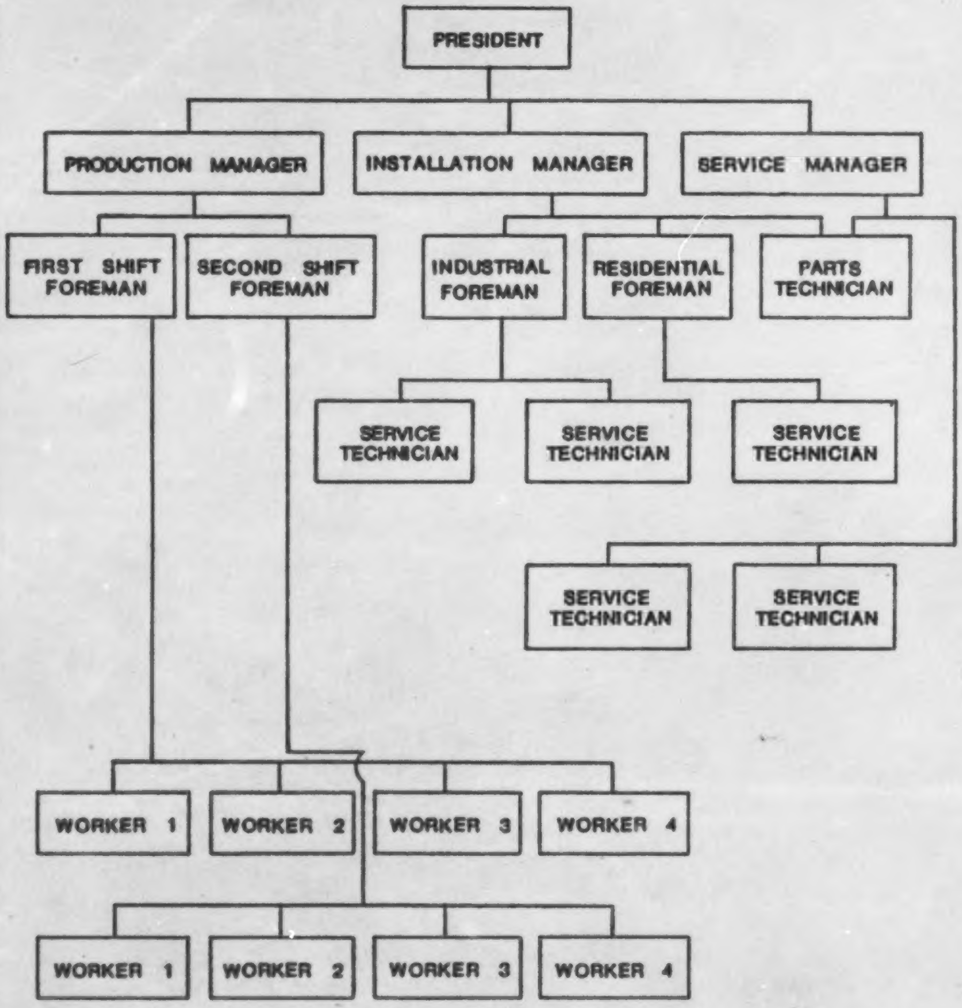

Math
Chem
UTC
Fuel Combustion
Fluid & Thermal Prin.
Boilers
Math
UTC
Fluid & Thermal Prin.
Mechanical Principles
Turbines
Chem
Power Plant (Water) Chemistry
ENERGY PRODUCTION (ELECTRICAL POWER PLANT)
Generators
Electro-mechanical Devices
Electrical Principles
Mechanical Principles
UTC
Electrical Transmission & Distribution Systems
Electromech. Devices
Electrical Principles
UTC
Math

Figure 8. Progression of Student Through Technical Courses for Energy Production (Electrical Power Plant) Job Requirements.

Example J is a typical organizational chart.

EXAMPLE J: HEADINGS IN A TYPICAL ORGANIZATIONAL CHART.


PRESIDENT
PRODUCTION MANAGER
INSTALLATION MANAGER
SERVICE MANAGER
FIRST SHIFT FOREMAN
SECOND SHIFT FOREMAN
INDUSTRIAL FOREMAN
RESIDENTIAL FOREMAN
PARTS TECHNICIAN
SERVICE TECHNICIAN
SERVICE TECHNICIAN
SERVICE TECHNICIAN
SERVICE TECHNICIAN
SERVICE TECHNICIAN
WORKER 1
WORKER 2
WORKER 3
WORKER 4
WORKER 1
WORKER 2
WORKER 3
WORKER 4

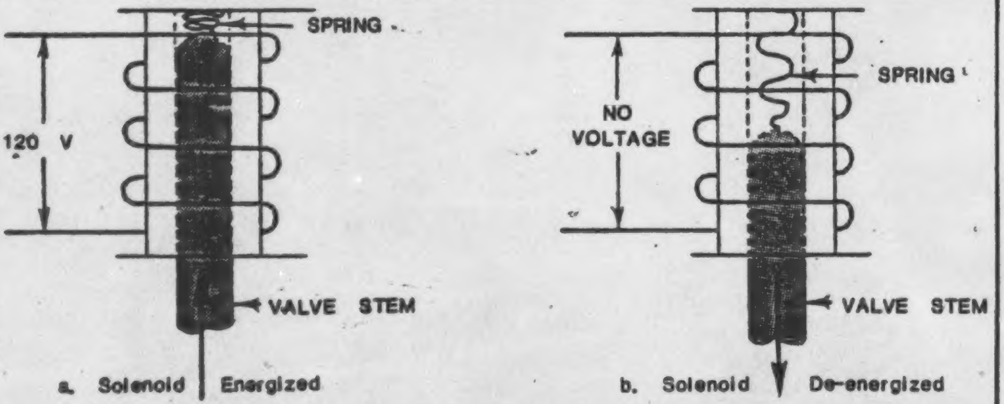
A line drawing is any drawing from a simple sketch. Line drawings range from a simple two-dimensional sketch showing how to attach a handle to a lever to a three-dimensional sketch scaled by a draftsman. Many line drawings are diagrams of mechanical parts, procedures, or schematic and wiring layouts.

A usable line drawing does not have to be beautiful. However, one should remember the following:

1. The drawing should be neat.
2. Items should either be drawn to scale or be proportional.
3. Remember: rectangles and square can represent almost anything; a line drawing does not have to be complicated to achieve its purpose.
4. A poor drawing may be better than no drawing.

Line drawings shown in Example K are simple and could be easily accomplished by a careful amateur:

EXAMPLE K: SIMPLE LINE DRAWINGS.



a. Solenoid Energized

b. Solenoid De-energized

Figure 9. Electrical Valve Actuators.

Example K. Continued.

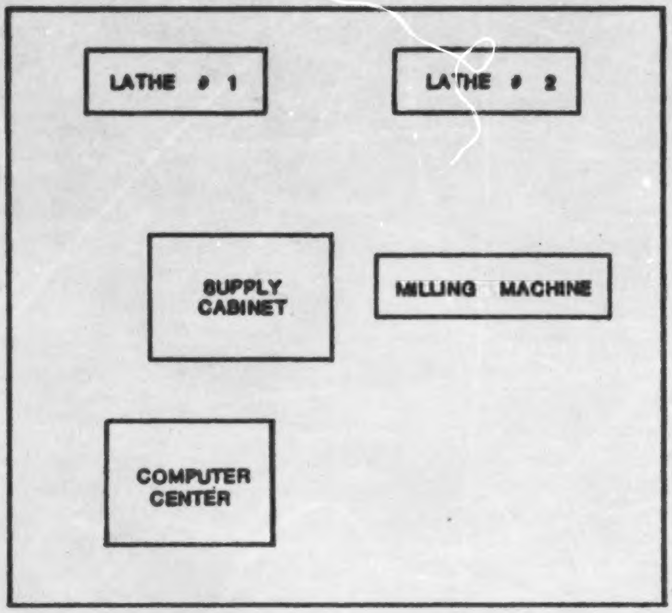

LATHE # 1
LATHE # 2
SUPPLY CABINET
MILLING MACHINE
COMPUTER CENTER

Figure 10. Proposed Shop Layout.

More complicated line drawings are illustrated by Example L. Complicated line drawings are not normally tackled by a technician.

EXAMPLE L: COMPLICATED LINE DRAWINGS.

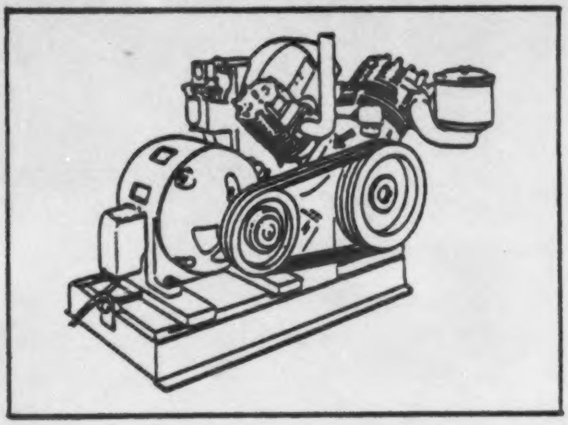


Figure 11. Typical Belt-Drive Setup.

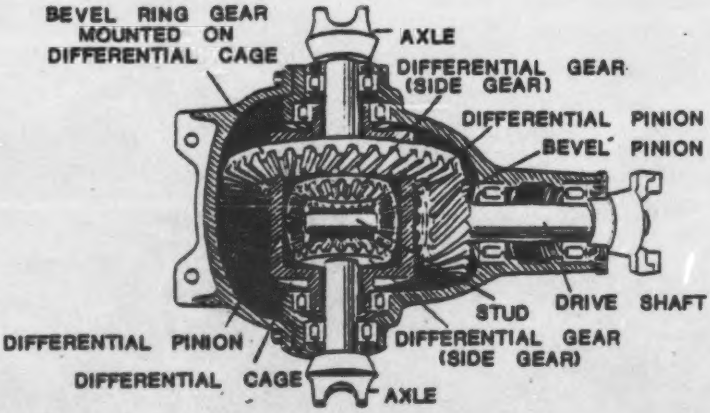

BEVEL RING GEAR MOUNTED ON DIFFERENTIAL CAGE
AXLE
DIFFERENTIAL GEAR (SIDE GEAR)
DIFFERENTIAL PINION
BEVEL PINION
DRIVE SHAFT
STUD
DIFFERENTIAL PINION
DIFFERENTIAL GEAR (SIDE GEAR)
DIFFERENTIAL CAGE
AXLE

Figure 12. An Automobile Differential.

Photographs may be the first illustration one thinks of when the term "illustration" is mentioned. Photographs are hard to take, more difficult to reproduce than line drawings, and may not show as much detail. In some cases, photographs get too much detail. Sometimes, the illustrator may want to use only selected details; if a photograph is used, air-brushing or similar touch-up techniques may be necessary. The technician should be sure that such exacting detail is necessary; otherwise, a drawing may be easier, clearer, and cheaper in the long run than a photograph.

General Suggestions For Using Figures

Each type of figure has special characterisitcs. To end this discussion of visual illustrations, here are a few suggestions that fit all types of figures:

1. All figures should be in the main text, unless they are simply nice to know – in which case figures should be placed in the appendix.
2. All figures should be at least mentioned, if not discussed, in the text before they appear.
3. All figures should be as simple as possible.
4. Most figures should fit in a half-page or less.
5. Figures should be as neat and appealing as possible.
6. Each figure should have a number and descriptive title.
7. Headings, legends, keys, notes, and titles should be used to make each figure self-explanatory. The reader should be able to understand the figure without reading the related text.

8. Symbols and abbreviations should be used, but only those that are familiar to the reader.
9. The writer or speaker should look for opportunities to use figures.

EXERCISES

1. Prepare and deliver a five-to ten-minute informative oral report on how something works or how to do something. Prepare visuals for the class, as well as handouts to distribute to the audience.
2. Prepare a five- to ten-minute taped interview with an instructor or employer. The objective will be to discover the most interesting aspects of the person, such as background, hobbies, family, occupational specialties, and so forth.
3. Lead the class in a three- to five-minute learning discussion. The purpose will be to discover the class' opinion on a current world, national, or local problem.
4. Research some aspect of school (class makeup, home area of freshmen, major of class, etc.) and present the information to the class in three different visual forms. Explain the advantages and disadvantages of each form.
5. Select a report done for an earlier assignment and prepare three or more visuals for it.
6. Prepare three rough visuals for a classmate's earlier report.
7. Prepare a flow chart that illustrates a technical operation.

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TEST

1. List four situations in which a technician will have to use oral skills.

2. List six steps in constructing an oral presentation.

3. List two questions to be asked by the speaker when selecting the subject for an oral presentation.

4. List four aspects that should be examined when analyzing an audience.

5. Which method of delivering an oral presentation is best?

6. List two ways of beginning and ending an oral presentation.

7. List three ways of verbally developing a main point in the body of a presentation.

11. List three suggestions for handling the mutual exchange period of a person-to-person transaction.

12. List three suggestions for handling an interview.

13. Compare formal and informal tables.

14. Define bar graph, circle graph, line graph, flow chart, organizational chart, and line drawing. Give two suggestions for constructing each.

8. List two suggestions for using visual aids in an oral presentation.

9. How can group communication be classified?

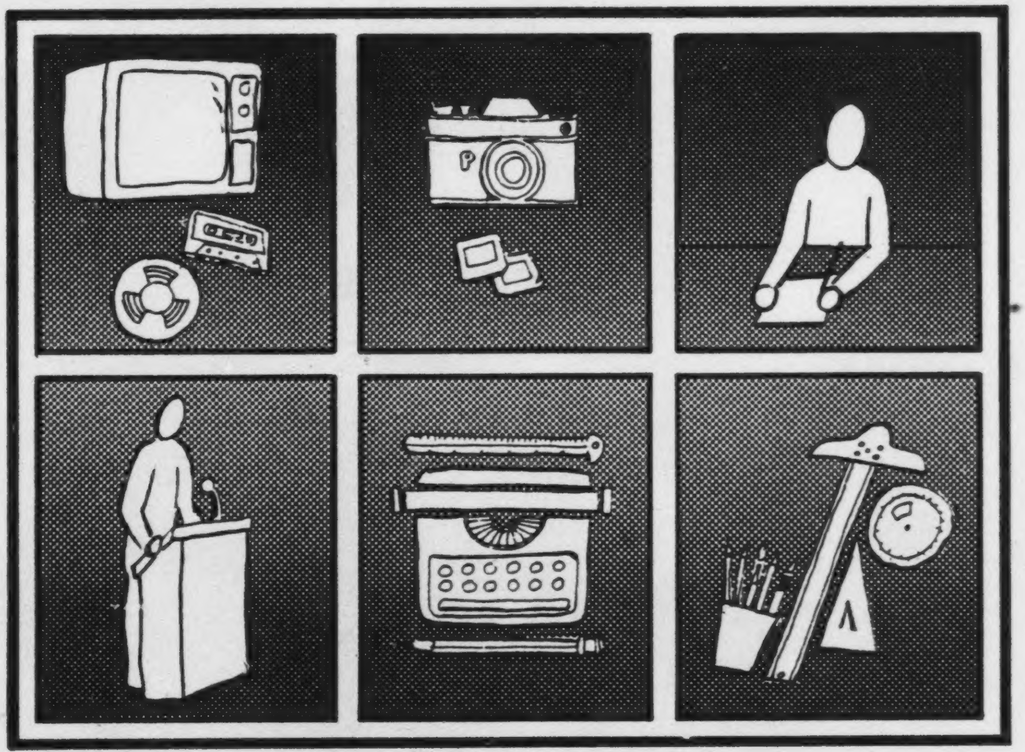
10. List steps in preparing to lead a group discussion.

ecut

ENERGY TECHNOLOGY

CONSERVATION AND USE

TECHNICAL COMMUNICATIONS



MODULE TC-08

PUTTING SKILLS INTO PRACTICE: FORMAL REPORT AND PRESENTATION

CORD CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

INTRODUCTION

Technical Communications has examined each kind of writing exercise a technician may be asked to complete. This module, TC-08, "Putting Skills Into Practice: Formal Report and Presentation," attempts to link the student's writing accomplishments.

Rather than presenting new information, this module reviews previous material so that the student can have an opportunity to apply the knowledge. In some cases, previous modules are listed as a reference; in others, suggestions are repeated.

PREREQUISITES

The student should have completed TC-01, "Introducing Technical Communications"; TC-02, "Conducting and Reporting Research"; TC-03, "Writing Outlines and Abstracts"; TC-04, "Writing Definitions"; TC-05, "Describing Mechanisms"; TC-06, "Describing a Process"; and TC-07, "Performing Oral and Visual Presentations."

OBJECTIVES

Upon completion of this module, the student should be able to:

1. List aspects of a report topic over which a writer has control.
2. List ramifications of selecting the purpose for a report.

3. List characteristics to be considered in an audience analysis.
4. Know possible legal ramifications of a report.
5. List and explain three steps in developing a plan for a report.
6. List four items of information that should go on a note card.
7. List items a formal report usually contains, indexing them under three general headings.
8. Explain the purpose of each of the three major sections of a formal report.
9. List and define four objectives an introduction should accomplish.
10. Know how to construct summaries, conclusions, and recommendations.
11. List some suggestions for revising rough copy.
12. Know the advantages of presenting a written report orally.
13. Understand the statement, "A report will never be perfect."
14. Select a topic suitable for a formal report.
15. Conduct preliminary research.
16. Construct and adapt an outline.
17. Take notes for a report.
18. Write a rough draft of a formal report.
19. Present an oral report that includes a defense and a question-and-answer period.

PUTTING SKILLS INTO PRACTICE: FORMAL REPORT AND PRESENTATION

Modules in this course have tried to equip the student to handle the communication situations normally encountered by a technician.

Subject matter has touched on the techniques and assignments that may become job assignments: writing definitions and descriptions, adapting communication to a specific audience, researching a topic and reporting the findings, preparing an oral presentation, and other such tasks.

Now that the student has studied key areas that may later be assigned duties, this module assimilates previous topics into one integrated assignment – the formal report.

A formal report can, and usually does, involve most aspects of technical communication, such as analyzing the audience, identifying objectives, developing a plan, writing and rewriting, reporting results orally, and revising rough copy. The technician is expected to be able to handle report writing as methodically as an energy audit, a laboratory experiment, or a diagnosis and repair.

SELECTING THE TOPIC

A technician normally does not choose the subject of a written report. Usually management – or aspects of the job – controls what subjects must be researched. This does not mean that the technician has no control, for the subject must always be narrowed, defined, and clarified. The point of view, the level of language, the organization, the objectives, and the specific aspects to be covered are all illustrations of areas over which the writer has control, even when the subject is assigned.

The technician rarely chooses the topic. Sometimes, however, the technician makes suggestions for company improvements to management through writing a formal report. For example, if the technician discovers that more efficient lighting can save the company money — or that a new heating unit could pay for itself in five years — a formal report suggesting changes is in order.

The writer should look carefully at the objectives of the report. As stated in earlier modules, "no purpose, no plan." A report written to convince management to change its policy differs from a report written to inform management.

In considering the report's purpose, the technician must consider the report's ramifications. Objectives should be realistic and not more extensive than necessary. More extensive objectives might be set for a report that affects a $100 million budget than a report that affects a $10,000 expenditure. If a report must be written in a week, the writer should avoid objectives that require extensive research or experimentation. The technician must first determine what the audience needs to know and then reveal only that information to the audience.

ANALYZING THE AUDIENCE

When the subject has been selected and narrowed and the purpose specified, the next step is to analyze the prospective audience. The module on oral presentations discussed some key aspects to consider when making an audience analysis. The technician must remember that the audience can be either readers for a report or listeners to a presentation. In either case, procedures are about the same. The technician must determine the audience characteristics so that all aspects of the report can be adapted. Many times, management assigns the report; the report would be aimed strictly for management. At other times, however, the audience may be quite varied.

Obvious audience characteristics to be determined are sex, age, knowledge of the subject, and relation to the subject. Other items that sometimes play a part are cultural background, vested interest in the company or project, income level, occupation, political preferences, and educational level. To find these out, the technician may need to do a bit of research. On the other hand, simply reading or hearing other reports prepared for the same audience may answer all the important questions – if the technician is perceptive.

In some instances, the communicator may need to adapt the report to the reading level of the audience. If this is required, the technician must first determine the reading level of the audience. Next, the report must be tailored to the necessary level. Experts, like Rudolph Flesch and Robert Gunning, have suggested formulas for analyzing the reading level of a piece of writing.

In actual practice, such a scientific approach would seldom be attempted, but Flesch's and Gunning's ideas might be applied to technical report construction. Both men base their readability formulas on (1) sentence length and (2) number of syllables, since longer sentences and big words sometimes make writing and speaking harder to understand.

Technical communicators can pick up a few suggestions from readability formulas. First, sentences should be moderately short, but length should be varied. Second, the common familiar word should be chosen whenever possible. In some cases, technical words that would confuse readability experts are simple words to a technically-oriented audience. The longest word may actually be the simplest description of intended meaning. In some instances, a simpler word may not be available. However, unnecessary words should always be eliminated. Economy and exactness contribute to reading ease.

The technician should remember that any part of any report can have legal ramifications. Recent litigations, especially in the automotive industry, exemplify that a technician's report may later become legal evidence. If a technical report diagnosed inadequate safety factors that later resulted in an accident, the report might be the main evidence in a lawsuit. If the technician is careful to be specific and exact, no problems should arise.

DEVELOPING A PLAN

After selecting and narrowing the topic and analyzing the audience, the next step in preparing a formal report is to develop a detailed plan. Three possible stages in developing a plan are (1) gathering preliminary information; (2) preparing an outline; and (3) compiling specific materials.

Gathering preliminary information can be tackled several ways. The up-to-date technician keeps a file of information that may be of future use; this file should be consulted. What could be included in an information or idea file?

Current technical developments should be indexed, such as new techniques, improved devices, results of experiments, and hints for improved operations. This file is also a good place for the technician to keep ideas for future reports, improvements, and proposals.

If the report requires any research, the technician's first job after narrowing the subject and identifying the objectives is to make a list of possible sources. Module TC-02 gives suggested methods and possible sources that can help in assembling a preliminary bibliography or list of sources. The extent of this preliminary search depends on the purpose and complexity of the problem.

Suggested ways of conducting a preliminary search listed in Module TC-02 are not directed toward a particular technical discipline. A technician's idea file should include specific indexes, dictionaries, bibliographies, and abstract services that have been helpful. No general discussion can take into account the many helpful sources that the well-versed technician will find. After sufficient development, the technician's idea file may become the most treasured resource in the office.

After conducting the preliminary research and before making the outline, interviewing others can add additional ideas, if done selectively. Usually, the technician has acquaintances or access to others who can provide input and save time. A knowledgeable person may know shortcuts or recent sources that a short interview can uncover. Several suggestions for conducting interviews are listed in the module about oral communications. The interview need not be formal; a few brief questions may be sufficient.

Preparing an outline follows gathering the information. The module on outlining contains some suggestions for developing a tentative outline. The first step is usually brainstorming during which the technician should (1) list all subjects that might be included and then (2) try several arrangements. The suggestion of placing the topics randomly on a page and experimenting with their order should be tried. Which topics should be included? Which items should be main topics and which should be subtopics? What order should be followed? These questions can best be answered by using a preliminary outline.

The writer should remember that a tentative outline is an educated guess, but it is tentative. Changes are inevitable; however, the more brainstorming, the more the final outline will resemble the rough outline.

As suggested in the outlining module, a key element in any tentative plan is a cooling off period. The tentative outline should be constructed and then allowed to cool. Putting the outline aside gives the technician's subconscious a chance to work. A writer or speaker should always work on a project, put it aside, and then work on it again. In this type of task, the goal is not to be finished in one effort.

The last step in developing a plan is compiling specific information. After gathering preliminary information and preparing an outline, the communicator must assemble the specific documents and materials necessary for the final report. Module TC-02, "Conducting and Reporting Research," contains suggestions for compiling information.

1. Notes should be taken on note cards.
2. Four items of information should be on each card: the topic, the source, the page or pages from which the information came, and the notes themselves. Since a preliminary outline has been made, the topic at the

top of each card should be the division of the outline under which the information fits.

3. Information from two sources (or information from one source that covers two different subdivision of the outline) should always be put on separate cards – not combined on one card.

If systematically followed, this simple note-taking method can be used to compile information for a short report or for a series of lengthy reports. This method of taking notes can be used for a report that will be completed in a month – or for a research project that will cover several years. If the researcher (1) does not mix information from different sources or deal with different subtopics on one card and (2) if all four pieces of information are on each card, this basic note-taking system is an excellent way for the average technician to store information for future reference.

In addition to notes, the technician must also locate or produce actual tables and figures that will be included in the report. At this stage, rough sketches may be constructed, but the information for each item should be compiled. Requests should be made to publishers before reproducing any previously published illustrations if the report is to be distributed. The module on visual illustrations contains suggestions for preparing various charts and figures.

WRITING A ROUGH DRAFT

The rough draft of a formal technical report is approached only after much careful preparation has been completed. When this step is begun, the technician will have chosen a subject or narrowed and refined the subject given him. The report's purpose will have been defined. A preliminary search will have been conducted to determine what information is available.

MAKING AN OUTLINE

The preliminary search leads to the plan, in this case, the outline. Using the outline as a guide, the writer makes notes over the portions of the sources that provide information on the topics of the outline. Sometimes, the outline will be expanded as new important information is discovered; sometimes portions of the outline will be eliminated when the writer sees that no information is available – or that the available information does not contribute significantly to the purpose of the report. When note taking is completed, the information and the outline will match, usually because both were modified somewhat from the writer's original intent.

A good researcher must approach each research project with an open mind, which means that the end result may not match the original plan. Each person who plans and writes a formal report sets out with a tentative purpose, plan, and conclusion in mind. However, the technician should approach the task scientifically and objectively. Seldom is the objective to prove a preconceived idea. Usually, the report is the result of research and is, therefore, the vehicle for tracing a study of some type, drawing logical conclusions, and perhaps making recommendations. The report is a scientific document that has legal ramifications, and it should be treated as such.

ASSEMBLING THE ROUGH DRAFT

When the technician finally sits down to assemble the rough draft, the hard work is finished — if the previous suggestions have been followed. Writing the rough draft consists of putting the notes and illustrations into the form and format required by the company for which the report is being prepared. The writer should attempt to produce a complete copy. However, polishing should be undertaken only after a complete copy is finished. Careful editing must be done after a complete copy is polished.

As has been said so many times in this course, there is nothing magic about any format. The secret is not to memorize one style, but to be sensitive to whatever style the company expects. Style and format should be treated as a formula: just as mixing certain chemicals produces the ideal chemical reaction, joining well-phrased thoughts with the assigned format evokes praise, success, and the appropriate reward.

Regardless of the format dictated by the company stylebook, most formal reports (see formal reports section of the module on research) contain approximately the same items, which are the following:

- Title page
- Transmittal correspondence
- Table of contents
- List of illustrations
- List of definitions and symbols
- Abstract
- Introduction
- Detailed information
- Conclusions or summary

- Recommendations
- Bibliography
- Appendix

Some of these items are called by different names, and the order may vary, but most are included within a formal report in some way.

Prefatory Pages

One way to categorize the parts of a formal report is to consider the first portion leading to the introduction as prefatory pages – or pages that precede the body. These pages are often called the front matter. The introduction, the detailed information, the conclusions or summary, and the recommendations are usually considered the body. The bibliography, the appendix, and the glossary are normally called the appendix, or the back matter. These portions of a report are supplementary items. Although the formal report may have many parts, a formal report can be thought of as having only three major divisions.

The prefatory pages, or front matter, of a typical formal report include the following items:

- Title page
- Letter of transmittal
- Table of contents
- List of figures
- Abstract

The purpose of prefatory pages is to prepare the reader, so each company has slightly different requirements. The second module suggests ways of constructing prefatory pages, but a brief review of some points may be helpful.

The writer should follow the company's prescribed format for the title page. If no sample is available, the title, the writer's name and title, the company, and the date should be distributed evenly on the page.

The letter of transmittal, also referred to as the transmittal correspondence, should usually be a conventional business letter. The body should state (1) the title of the report; (2) when the report was requested; (3) the report's purpose and scope; (4) problems encountered; and (5) any assistance received.

The table of contents lists the contents of the report and where to find each part. It should match the outline that the writer used to organize the notes, but the table of contents usually contains items an outline would not: for instance, lists of figures, abstract, page numbers, and appendix. Formats vary; the writer should check the company stylebook carefully. The illustration in Module TC-02 is typical, but displays only one style.

Headings and subheadings on the outline appear in the body of the report as headings. All headings in the body do not have to appear in the table of contents, but headings listed in the table of contents must, of course, appear in the body of the formal report. Having headings appear both places provides guideposts for the reader throughout the report.

Most reports index visuals separately. The list of figures follows the table of contents. Some authorities suggest separating lists of tables and illustrations.

To the reader, the most helpful prefatory page is usually the abstract, which is a short objective summary of the report. Although the abstract appears early in the report, it should be written last to reflect changes in the writer's original plan. An abstract should be informational and should summarize the report's key ideas. A reader who might have trouble with the technical aspects of the body should be able to understand the abstract. The abstract will help a busy manager determine whether to read the entire report or not.

Body of the Report

The body of the report usually contains the introduction, detailed information, conclusions, and recommendations. The body is sometimes called the discussion section. Companies may call these parts different names.

The first section of the body is called the introduction. The introduction (of the body) should accomplish four objectives: (1) state the subject of the report; (2) state the purpose of the report; (3) the scope of the purpose; and (4) state the plan for development of the body. In stating the subject, the writer should not only state the topic, but should also clarify any preliminary aspects necessary for reader understanding. The writer may need to discuss theory, history, definitions, or background. The writer's job is to analyze the audience well enough to determine which aspects of the subject need preliminary explanation or elaboration.

Stating the purpose should be easy, since the writer has spent so much time refining the purpose during prepatory stages. Clarification of purpose results in a better report for the reader and a clearer path for the writer. Although the purpose does not alway have to be as obvious as "The purpose of this report is ...," there is nothing wrong with stating a purpose in this way. If the writer does not say, "The purpose is ..." then the purpose should be stated in an equally clear way. There should be no doubt in the reader's mind as to what the writer was attempting. Verbs like "to discuss" may detract rather than help. Direct verbs such as compare, analyze, determine, and recommend should be used.

The scope sets limits for the purpose. The purpose may be "to compare three heat pumps." If so, the scope might be: "This comparison will include only the operating characteristics," or "This comparison will be based on a three-week laboratory test under simulated operating conditions."

The plan for development can be constructed by stating the main points from the table of contents in one sentence. The writer does not elaborate on main points – points are simply listed in this introductory portion.

Detailed information, although constituting eighty to ninety percent of the report, is really the easiest part of the formal report to write. If the writer has (1) developed a good outline and (2) organized the notes around the outline, writing the discussion is relatively simple.

Notes should be assembled into a readable, logical report that is adapted to the target audience. Organization should be automatic, since each note card will be coded by the division of the outline under which it fits. The writer's task, at this point, is to arrange notes with the same heading at the top into a logical sequence.

As the notes, which are usually summaries, are expanded and explained in the report, the writer must make the final product a smooth, flowing report – not just an assortment of facts and figures. This quality of smoothness, or the evolution of one idea into another, is called transition. Even when incorporating transitionary elements, the writer should be concerned with directing the report toward a specific audience. Transition should be developed during the preliminary rough draft; refinement of transition usually takes place during the work on the final draft.

Two aspects of the body deserve special attention: headings and footnotes. As discussed both in this module and in TC-02, titles and subtitles from the table of contents appear within the body of the report to serve as guideposts for the reader. They allow the reader to find topics, as well as divide the report into manageable segments.

There are several ways of including headings within the body. Usually no more than three levels are used — first order, second order, and third order. As in the outline, headings should not stand alone, but should be organized in twos. For example, if there is one third level heading, there must be another third level heading placed with it. First order headings are the major divisions of the table of contents. They are usually considered section titles within the body; therefore, they appear at the top of a new page in all capitals.

Second order headings are subdivision of major divisions. They are usually flush with the left margin and on a line by themselves in the body. Third order headings are usually indented in the body, are followed by a period, and have text on the same line. The three levels would probably appear as in Example A; however, rules for capitalization and placement sometimes vary between companies.

EXAMPLE A: DIVIDING THE FORMAL REPORT WITH HEADINGS.

FIRST ORDER HEADING

Text begins here and the first order heading is always placed at the top of new page. There must be text between the first order and second order heading.

Second Order Heading

Text begins here.

Second Order Heading

Text begins here.

Third order heading. Text begins here.

Third order heading. Text begins here.

Footnotes are also an important aspect of the body. Footnotes may contain explanations, additional information, or references. Footnotes may be identified with an asterisk, but usually footnotes are numbered and a corresponding number is placed in the body to identify the word, sentence, or section to which the footnote refers.

Footnotes must contain references or documentation for all material that is summarized, referred to, or quoted from another source. Again, style depends on what is required by the company. Example B contains four style guides, as follows:

EXAMPLE B: FOOTNOTES CITING APPLICABLE STYLE GUIDES.

1. CBE Style Manual. Third edition. Washington, D.C.: American Institute of Biological Sciences, 1972.

2. MLA Handbook for Writers of Research Papers, Theses, and Dissertations. New York: Modern Language Association, 1977.

3. Style Book and Editorial Manual. Fifth edition. Chicago: Scientific Publications Division. American Medical Association, 1971.

4. Style Manual for Guidance in the Preparation of Papers. Second edition. New York: American Institute of Physics, 1967.

Footnotes can be at the bottom of the page, at the end of each section, or at the end of the report. The company's style should be followed.

The body usually ends with conclusions, a summary – or both. Depending on the nature of the report, the body can also contain recommendations based on the contents. It is often assumed that conclusions, summaries, and recommendations will follow detailed information. However, some companies require that the results come first, so that the reader can read the conclusions before tackling details.

Any of these terminations – conclusions, summaries, recommendations – call on the writer to be scientific and accurate. In an informational report, the writer usually ends with a summary. The summary should identify key ideas without adding new material. A summary may either be in paragraph form, or it may be a numbered list. If the summary is a list, it should be introduced with a short sentence, such as in Example C:

EXAMPLE C: SUMMARIZING THE REPORT.

This study seems to illustrate the following:

1. **First summary statement.**
2. **Second summary statement.**
3. **Third summary statement.**

Conclusions are based on an evaluation of the evidence. The writer must examine data and then point out what the examination proves. It is better to say, "These tests suggest that a new method should be used" - rather than, "This experiment was unsuccessful." Positive conclusions are written as in Example D.

EXAMPLE D: WRITING POSITIVE CONCLUSIONS.

1. When used only for surface water, the McWhirter pump is more maintenance-free than the Atlas pump.
2. Under three simulated jungle situations, the McWhirter pump cost $.04 per hour to operate; whereas, the Atlas pump cost $.01 per hour. However, tests were too brief to be conclusive.
3. The design of the Atlas pump requires less training for the operator.

Recommendations, which are included in many reports, are based on conclusions. Recommendations suggest future action. For instance, following the previous conclusions on the McWhirter and the Atlas pumps, the writer might recommend which pump the company should purchase. This kind of conclusion is relatively easy to determine. But consider another situation: a study is made to determine the practicality of installing a solar heating assist unit. The researcher finds that cloudy and sunny days are about equal in number and that conclusions are about even, pro and con. Under these circumstances, recommendations become complicated.

Conclusions and recommendations must be based on evidence and intuition. Conclusions, which usually come first, state the evaluation of evidence; recommendations present solutions to a problem.

Recommendations may be written in either second or third person, depending on the company's (and the writer's) purposes.

EXAMPLE E: WRITING RECOMMENDATIONS.

SECOND PERSON:

> **You must provide adequate ventilation when mixing chemicals.**

THIRD PERSON:

> **Adequate ventilation must be provided when mixing chemicals.**

Sometimes, conclusions and recommendations are presented under one heading. If they are together, care should be taken to distinguish the two.

Appendix

The appendix, often called the back matter, is supplementary material placed at the back of the report. In its simplest form, the appendix might be only a bibliography or some specifications sheets. Four items may be included in the final section: (1) a bibliography; (2) an appendix; (3) a glossary; and (4) an index. Some authorities categorize all this information under the term "appendix." Others call only the additional information that could have been placed in the body, but which was considered non-essential by the writer, the appendix. Usually, a technical report does not have an index. This is because management does not usually expect a formal report to be widely distributed, or used as a reference. Therefore, the index is not necessary – nor is it worth the required investment of time and money.

The key to understanding what appears in the appendix is the word, supplementary. Anything that would be helpful, but does not fit into the main text, should go in the appendix. If the reader must read the appendix to understand the main text, the material should be moved from the appendix into the main text. It is not unusual, however, for the appendix to contain more information than the body. The appendix may be divided into several sections: "Appendix A – Transistor Specifications," "Appendix B – Possible Applications," and "Appendix C – Tube Base Diagrams," for example.

POLISHING THE FINAL COPY

The final copy is simply a polished rough draft. This step gives the writer a chance to look for omissions and breaks in logic, as well as mistakes. Certainly, this is the time to look carefully for errors of all types. Do numbers correlate? Are there contradictions? Is each illustration explained? Are heading correct? Do headings match the table of contents? Does the report follow the original outline – or was the outline changed?

The writer must also check the logic and flow of the report. Do the parts fit together well? Are transitions smooth? Are notes from different sources woven into a readable whole? Some authorities suggest reading the body aloud to search for logic and flow.

Polishing of the final copy must also include such items as checking for misspelled words, comma errors, and other mechanical slips. Letting some time elapse between completion of the rough draft and the revision is helpful. An unbiased reader can usually find errors that the writer cannot.

PRESENTING THE REPORT ORALLY

The technician is lucky if the report is to be presented orally. This is because of two benefits. The first benefit is that organizing to give the report orally is an excellent way to determine key points. If the technician must present the report from an outline or rough draft – rather than from the final copy – a second benefit accrues. The second benefit is that the technician can rely on audience input to point out the report's weaknesses.

The module on oral presentations gives suggestions on preparing an oral report. The written report and the oral report follow the same plan, with some exceptions. The oral introduction may contain illustrations, quotes, questions, or other types of beginnings suggested in the oral presentation module; whereas, the written report tends to begin more tersely. The oral conclusion may be only the written report's summary, conclusions, and recommendations or it may also contain quotes, personal intentions, or other types of endings, as mentioned in TC-07, "Performing Oral and Visual Presentations."

Other than the introduction and the conclusion, the oral and written reports should be almost identical. Depending on the formality of the situation, the oral presentation can be read or delivered extemporaneously. However, the audience will be more interested in the extemporaneous report. Only a few situations require that the report be read, since this is usually boring to both the reader and the audience.

Visuals in the report should be adapted to the audience. A large chart or drawing, a handout, a transparency, a slide — or all of these techniques — can be used to present the visual information in a report.

One advantage of presenting a report orally is that the preparer can get feedback as to which areas need clarification. The writer misses an excellent opportunity if the oral report is not followed by a question-and-answer period. The remarks, the questions, the digressions — all of these give the perceptive communicator clues as to which areas are clear, which areas need clarification, which areas need amplification, and which portions of the report are over-simplified.

FINAL REVISIONS

Each stage in the preparation of a formal report is an opportunity to revise, refine, clarify, and amplify the material. The writer does not save all revisions until last, although it is often best to complete the rough draft before careful editing is attempted.

Nevertheless, the writer does try to incorporate as many improvements into the final copy as possible. Changes should be based on editing principles, the results of any oral presentations in which the report has been used, comments by other readers, new information discovered since the report was begun, and similar sources.

On the other side of the picture, the report may never be perfect. This module has treated the formal report as if it were the technician's only project. In reality, the report will probably be only one task in the scope of the technician's duties. When the report meets the project objectives, the technician may stop writing so that time can be devoted to other duties.

To help students prepare a formal report, portions of a student paper are included in Example F. One should remember that styles and format vary; these examples present only one style. Other examples appear in the discussion of formal reports in the research module.

EXAMPLE F: COMPILING THE FINISHED PRODUCT.

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Example F. Continued.

ABSTRACT

Sludge is an ever present thing and must be disposed of in some way. Sludge used as an agricultural aid is a useful and direct means of returning nutrients otherwise lost to the food chain. With proper and careful treatment of the sludge, none of the associated diseases will have been spread to the public. Heavy metal and nutrient concentrations must be calculated and monitored to avoid toxic build up which will affect plant growth and can leach into ground water strata, thus becoming a public health concern. Public education of the desirability of sludge use in agriculture is an important step toward solving present sludge disposal problems.

Example F. Continued.

II. TREATMENT

In this paper, the disposal of residual wastes from a sewage treatment plant is being discussed. These residual wastes are the settled solids, sludge, from the treatment process.

Purpose

The purpose of treating sewage is to remove as much of the solids as possible from the carrier water before the water is discharged from the treatment plant.

The purpose of treating sludge is to inactivate the disease organisms present and prepare it for some sort of disposal. In present day sewage treatment methods, such as activated sludge, 3000 gallons of sludge is left for every one million gallons of sewage treated. With the advent of tertiary treatment, this amount of sludge will increase sixfold.[1]

Methods

There are many avenues open for sludge treatment. Each one must perform a sterilization process and, since sludge is about 95% water, concentration or dewatering to some degree is necessary.

Digestion. Either aerobic or anaerobic digestion will reduce volatile solids content satisfactorily. It has been found, however, that anaerobic digestion is most efficient at reducing BOD and pathogen levels. Aerobic digestion is the most costly of the two.

Composting. Composting has been accepted by the EPA as both PSRP and PFRP[2] (see appendix). Properly composted sludge reduces a sanitary humus-like material. Composting converts 20-30% of the volatile matter to CO_2 and water producing an overall volume reduction of 30-40%. Because the composted material reaches thermophilic temperatures, it is practically free of pathogens.[3]

Example F. Continued.

of money spent for the acquisition of land to be used in waste water disposal systems.[20] Recently, the EPA has given this grant money to help cover costs of leasing land as well.[21]

Agricultural Concerns

Municipal sludge, being a human waste by-product, has all the nutrients and trace elements that people consume at one time or another and do not use. This makes it an excellent fertilizer because it can supply any nutrient that a crop needs. The crop should be considered as to its abilities to absorb nutrients that are prevalent in the sludge. Corn has been found to be a good crop to crop in sludge treated soils because of its high uptake rates of nitrogen,[22] thus removing it from the soil and retaining it to the food chain.[23]

It is usually good to follow the normal crop patterns of the area. These patterns have become established because of favorable soil, climatic, and economic patterns and will probably maintain these advantages in a sludge application system.[24]

Costs. The EPA has determined that on an average in 1976 it cost $61/dry ton to dewater sludge and $24/dry ton to transport and spread this dewatered sludge for a total cost of $85/dry ton. The total cost of transporting and spreading wet sludge was $32/ton.[25]

Transportation. A tank truck is the most common method of transporting liquid or dewatered sludge. Trucks are the most energy consumptive but are more reliable and more flexible than other alternatives. Other alternatives often use trucks as an initial or final step in transportation. Other alternatives include barges, pipelines, and railroads.[26]

Application Rates. Sludge application rates recommended for crop production are calculated in much the same manner as commercial fertilizer application rates. The main limiting factor in sludge application is heavy metal concentration. The following formula has been worked out to determine the dry ton/acre limitations for a given sludge.

Example F. Continued.

IV. CONCLUSIONS

From this paper it can be concluded that:

1. Sludge is a necessary evil.
2. Careful conscientious treatment and management of sludge are essential to a successful sludge use program.
3. Sludge treated soil can increase crop yields above the yields achieved by commercial fertilizers.
4. Sludge use can lower or eliminate commercial fertilizer use on crop lands.
5. Sludge can be used to reclaim marginal lands.
6. Sludge can be safely used from both environmental and health standpoints.
7. Composting, heat drying, and digestion offer the best stabilization results.
8. Composted sludge offers the advantage of organic content.
9. Buying land outright is probably the best method of obtaining disposal sites because of the 75% reimbursement clause in the EPA law.
10. New stringent laws will force changes in municipal discharge practices.

Example F. Continued.

FOOTNOTES

[1] Grove Enrich, "Formulating Public Wastewater Policy," *Water and Wastewater Journal*. 40 (January 1978), 161.

[2] James Hinson, *Wastewater Treatment* (New York: New American, 1975), p. 24.

[3] Gerald Mann and Forest Herald, *Theory of Disposal* (Dallas: W & W Associates, 1977), p. 40.

[4] Water treatment varies in Spain. Key differences are discussed in John Lear's *"The Rain in Spain" and Where It Goes* (New York: Falls Incorporated, 1974).

Example F. Continued.

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Example F. Continued.

GLOSSARY

1. Aerobic — with the presence of air.
2. Anaerobic — without the presence of air.
3. BOD — five day Biochemical Oxygen Demand.
4. Chemical formula and names —

   NO_3 — Nitrates
   NO_2 — Nitrites
   NH_4 — Ammonia
   Ni — Nickel
   N — Nitrogen
   Cd — Cadmium
   Cu — Copper
   P — Phosphorus
   Zn — Zinc

5. PSRP — Processes to Significantly Reduce Pathogens.*
6. PFRP — Processes to Further Reduce Pathogens.*
7. SS — Settleable Solids.
8. Tertiary treatment — a third stage of treating wastewater making it of consumable quality.
9. Thermophilic — temperatures ranging between 45°-60°C.

* See next page.

EXERCISES

Unlike exercises for previous modules, all exercises for this module concern one project – the formal report. Each exercise is part of the final report; exacting completion of each exercise is important to the report's success. Exercises may be completed in a brief period of time toward the end of the course, or tackled task by task throughout the course, if the instructor wishes to incorporate student practice of the skills from each module as the material is studied.

1. Select three possible topics that meet the following criteria. The report will:
   a. Contribute to the student's knowledge.
   b. Deal with the student's major area and one other area on campus.
   c. Result in the report length that is assigned by the instructor.
   d. If necessary, involve both library research and personal experiments – but must be thoroughly researched.
   e. Be diverse, complex, or recent enough that no single source thoroughly discusses the subject.
   f. Be based on an adequate number of references. (The minimum number will be set by the instructor.)

   After criteria considerations, turn in three topics in order of preference.
2. Conduct a preliminary search for potential sources. Compile the list into a formal bibliography. Minimum number of references and bibliographical style will be set by the instructor. Place the tentative title of the formal report on the top line instead of the word "Bibliography."

3. Construct a tentative outline for the report, placing the tentative title on the top line.
4. Using the outline as a guide, take notes on the subject selected. Follow the format shown in the module on research.
5. Write an introduction of 100-200 words. Be sure to include the four essentials.
6. Construct a rough draft of the body of the report. Pay special attention to (1) assembling the notes in a smooth fashion, (2) inserting headings correctly, (3) utilizing visual illustrations, and (4) correctly documenting or footnoting all borrowed information.
7. Revise the body of the report.
8. Construct front matter and back matter.
9. Present a five-minute oral presentation. This should be followed by a defense and question-and-answer session with the class. The instructor may ask that others who might be affected by the formal report be guests during the oral presentation.

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TEST

1. List four aspects of a report topic over which the writer has control.

2. List three ramifications of selecting a purpose for a report.

3. List eight characteristics that can be considered in an audience analysis.

4. How may a report have legal ramifications?

5. List three steps in developing a plan for a report. Give three suggestions for each step.

6. List the four items of information that should go on a note card.

7. List the items, or parts, a formal report usually contains, indexing parts under three general headings.

8. Explain the purpose of each of the three major sections of a formal report.

9. List and define four objectives an introduction should accomplish.

10. Compare summaries, conclusions, and recommendations. What is the key to writing conclusions and recommendations?

11. List five suggestions for revising the rough copy.

12. Explain two advantages of presenting a written report orally.

13. Explain the statement, "A report will never be perfect."